SPIRE
Consortium Meeting

Cardiff, 4-6 July 2001

Presentations

Contents

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SPIRE Consortium Meeting
Cardiff
July 4-6 2001
Overview and Project Status

- AIMS OF THIS MEETING
- STATUS OF HERSCHEL MISSION AND SPACECRAFT
- REPORT ON THE SPIRE IIDR
- TOLEDO SYMPOSIUM

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Aims of the Meeting

- Report on project status and instrument design
- Consider options for photometer and FTS bands
- Clarify and improve overall Project Management, Organisation and System Engineering
- Discuss policies and priorities for use of SPIRE Guaranteed Time
- Meetings of
  - SPIRE Steering Group
  - Co-Investigators
  - SPIRE institute managers

FIRST Renamed as Herschel

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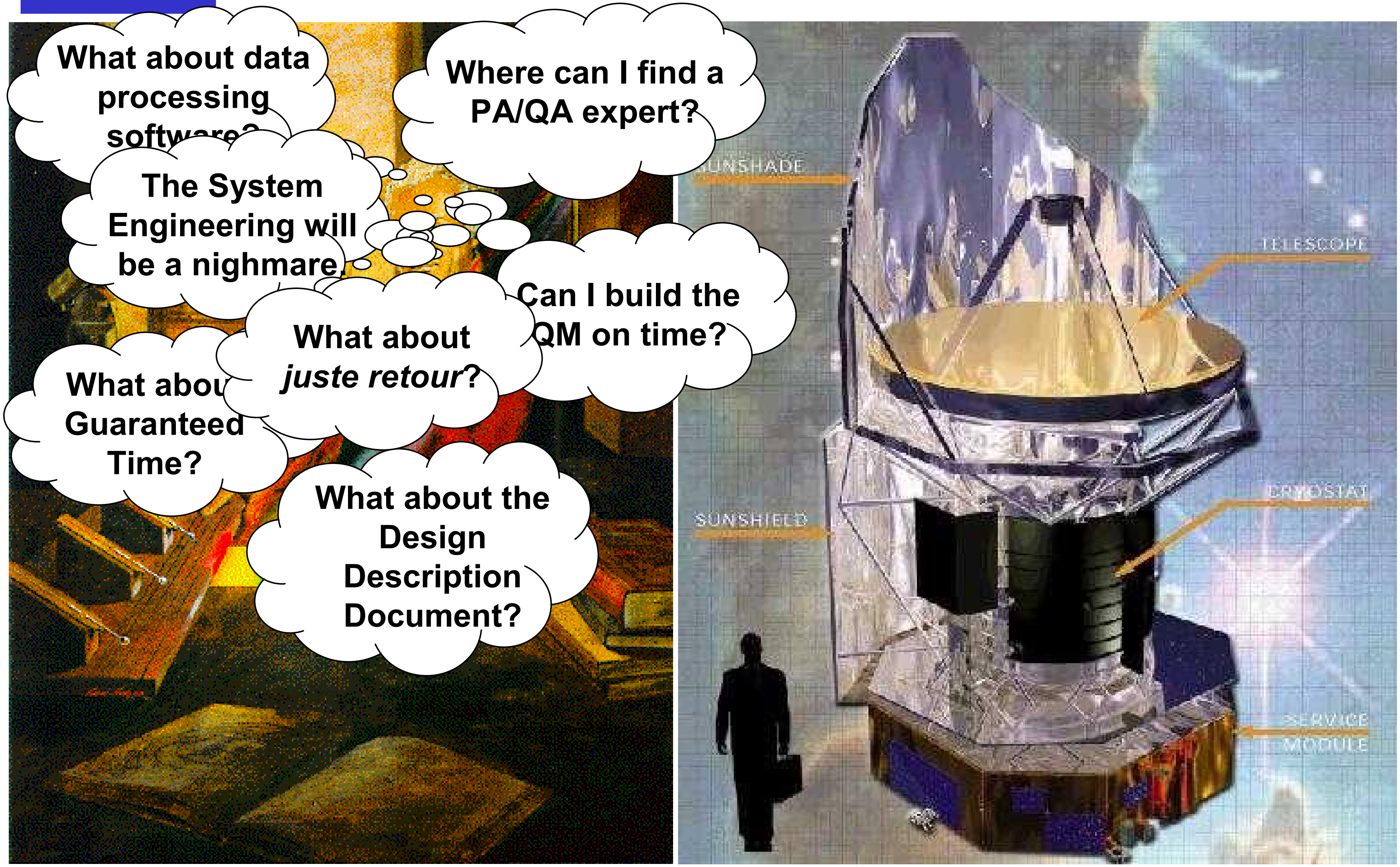
FIRST Renamed as Herschel



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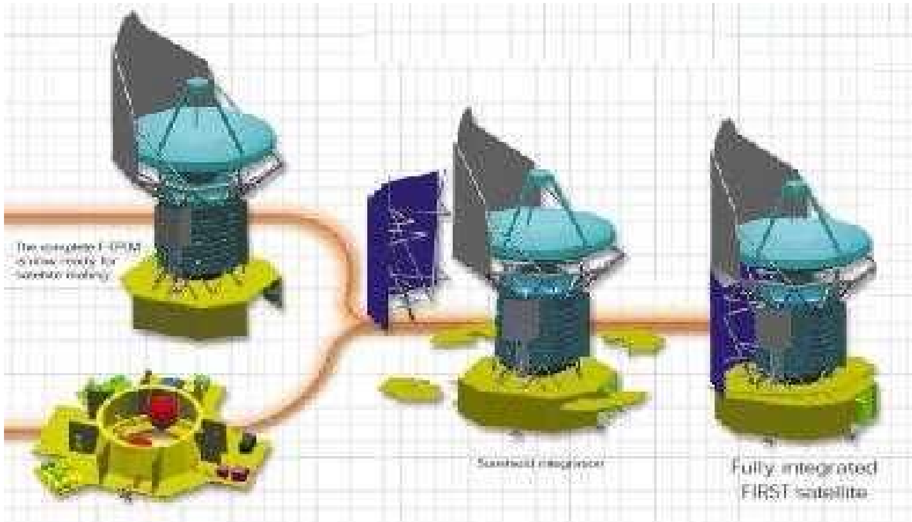
ESA Programme and Schedule

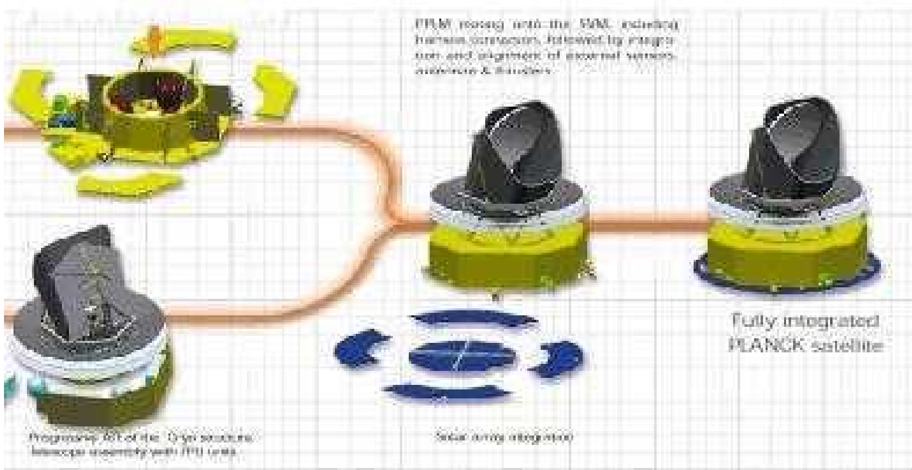
- **Project schedule is unchanged with launch on 15 Feb. 2007**
- **Herschel/Planck Prime contractor (and major sub-contractors) have just been appointed:**

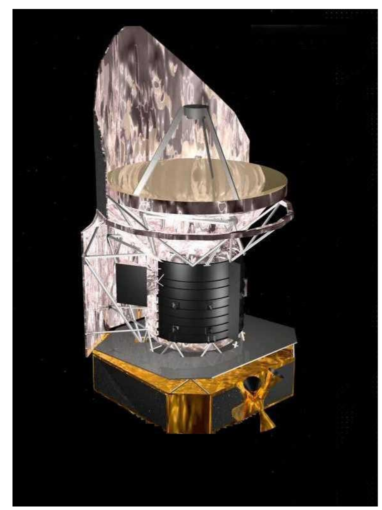
- Alcatel (France)	:	Prime Contractor
- Astrium (Germany)	:	Herschel Cryostat
- Alenia (Italy)	:	Service Module

- **Alcatel have proposed a dual launch instead of the Carrier option**
  - **De-couples Herschel and Planck AIT and eliminates system test of the combination**
  - **Better manoeuverability and SVM thermal stability for Herschel**

SPIRE Herschel/Planck Integration and Dual Launch







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ESA Programme and Schedule

- **Most of our direct technical contacts and interfaces will be with Astrium who will integrate the payload instruments in Friedrichschafen**

- **NASA have withdrawn from telescope provision. Astrium SiC telescope will be provided by ESA (not part of prime contract)**

- **ESA Project Team is being enhanced (to ~ 26)**

- **ESA have appointed Jackie Fisher as *Telescope Optical System Scientist* to join the Herschel Science Team**

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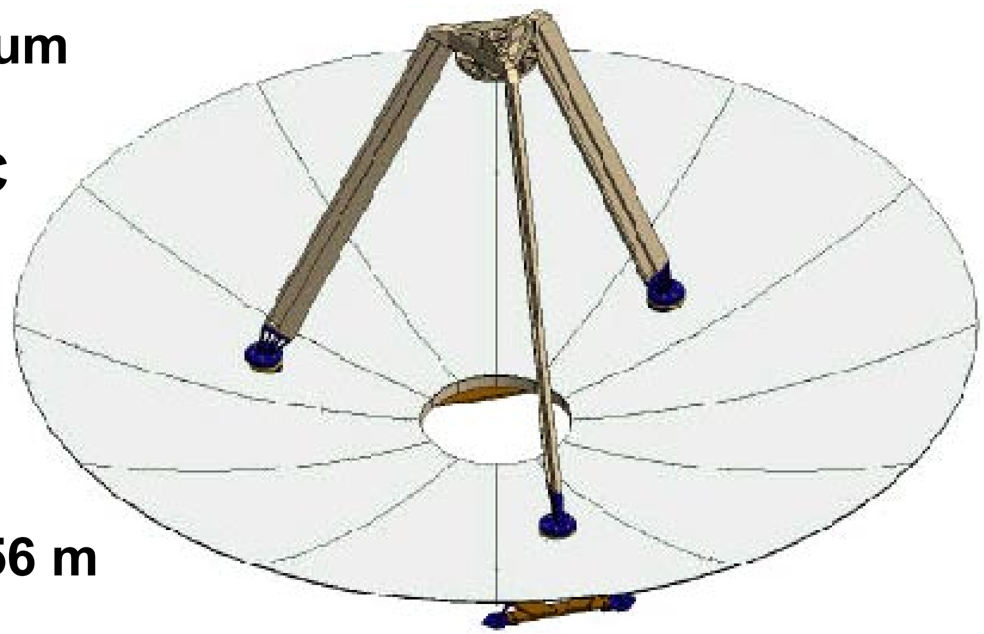
SiC Telescope



- To be provided by Astrium
- Primary, secondary, tripod all made from SiC
- Primary diameter 3.5 m
- Oven diameter = 3.49 m
    - Two 10-20-mm cuts to be made along opposite edges
- Cental hole diameter 0.56 m (~3% obscuration for 3.29-m used diameter)
- Reflector roughness < 50 nm rms
- Envisaged emissivity < 1% per reflector

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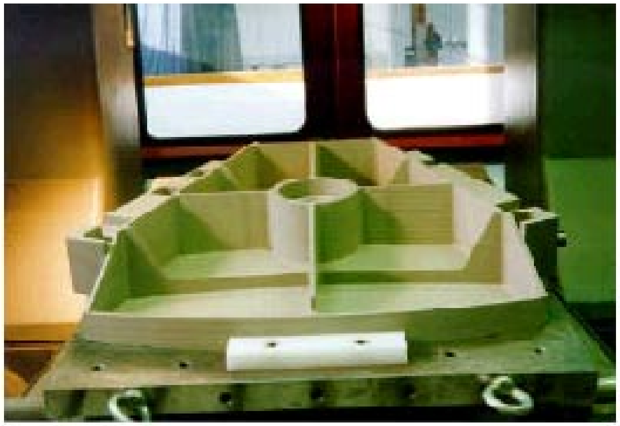
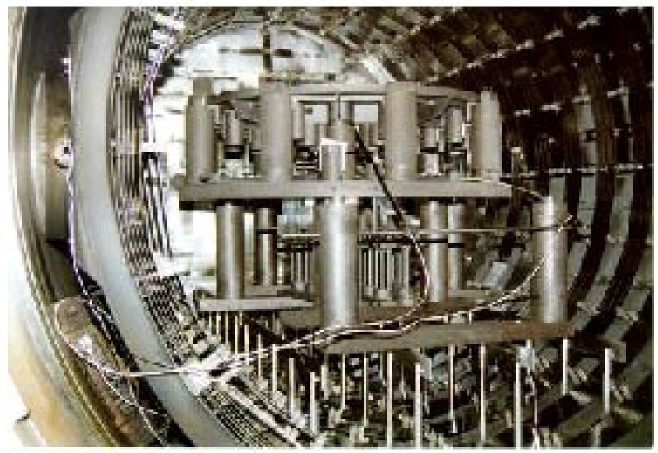
SiC Telescope



1- Segment green body machining (Boostec)

2- Segment sintering (Boostec)

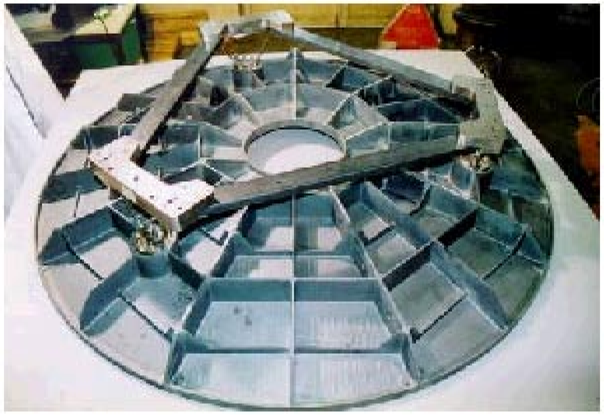
3- Grinding of brazed areas (Boostec)



4- Brazing (Boostec + Astrium support)
IABG oven TBC

SiC Telescope

5- Grinding of optical face (Boostec)



6- Bipod integration (Astrium)

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SiC Telescope

7- Polishing (Opteon)

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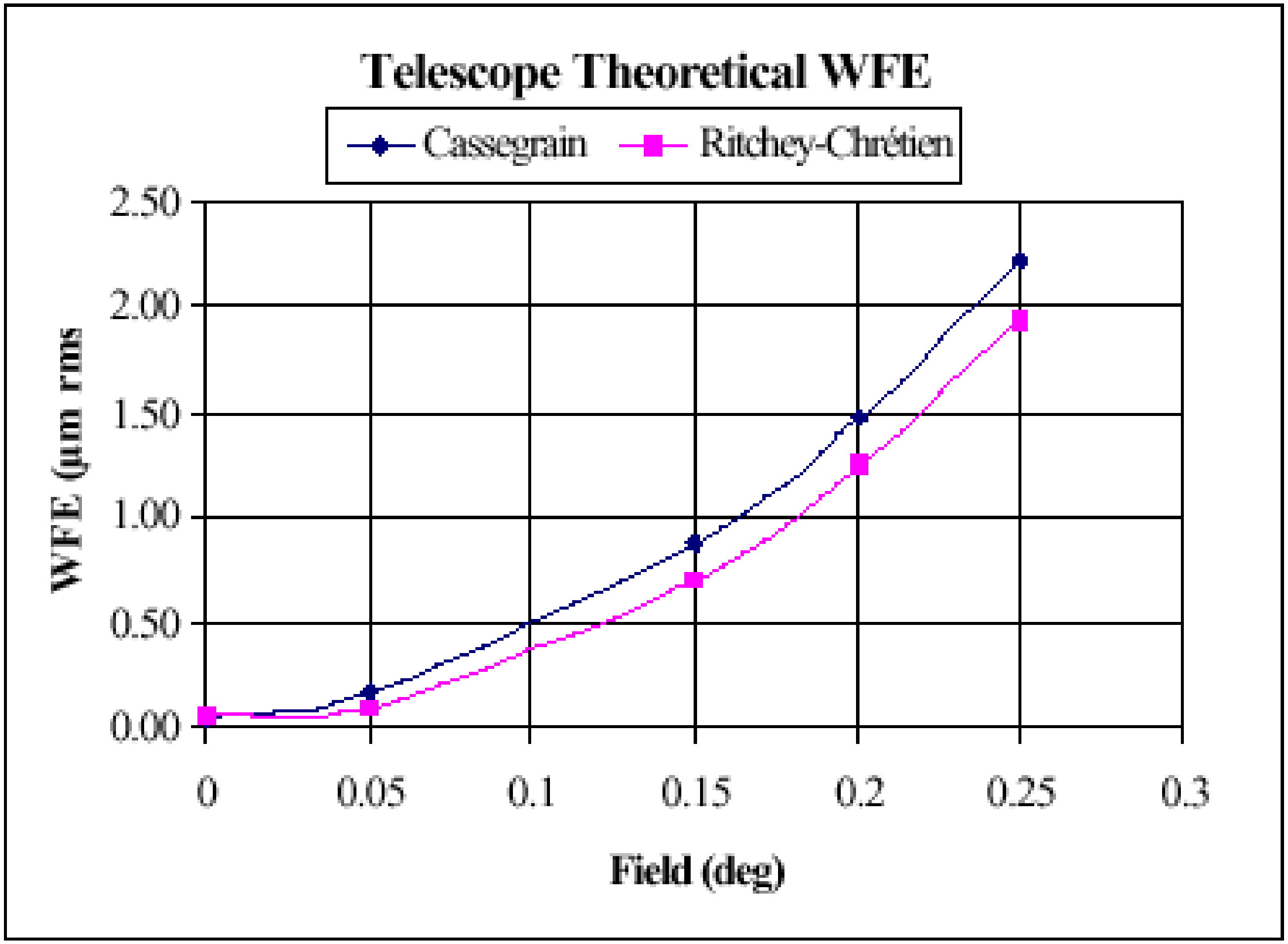
SiC Telescope



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Instrument schedules

- Delivery dates to ESA

	Required	SPIRE schedule
AVM	June 2003	1 June 2003
CQM	June 2003	1 October 2003
PFM	June 2004	1 September 2004
FS	July 2005	1 January 2006

- All three instruments have problems in meeting the required dates

- Possible solution (proposed by SPIRE):
  - Modified payload-level CQM test programme
  - Dedicated meeting on spacecraft AIT will be held in July

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SPIRE Reviews

• System Design Review	November 2000
• Instrument Intermediate Design Review	April 2001
• SPIRE Detailed Design Reviews	May – Aug. 2001
• Instrument Baseline Design Review	November 2001

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Highlights of IIDR Board Report

1. Main recommendation of November 2000 review well addressed
   - Consolidate the Design, Development and Verification Plan
   - Resolve the subsystem and overall schedule problem
   - Resolve and consolidate the proposed model philosophy

   But problems remain in schedule, model philosophy and PA

   Agree (except we believe model philosophy is the optimum solution given all the constraints)

2. Progress made to identify critical areas but presentations didn't identify solutions.

   Agree. In many cases solutions require joint effort by SPIRE, ESA and Prime.

3. Progress on subsystem level since System Design Review was not easily visible to the Board

   Late availability of IIDR documentation didn't help.
   November review was not a subsystem review.

Highlights of IIDR Board Report

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4. PA activity too low and FMECA should be used as a working design tool

   Agree. We are addressing this, but are resource-limited at Project Team level. Highest priority at present is to assist subsystems in closing off interfaces to allow procurement of long-lead items.

5. Serious concern over thermal design:

- Validity of the model presented	See later
- No margins wrt ^{3}He cooler operation	No (or clarification needed)
- JFET design not optimised to reduce dissipation.	It's not so simple
Present figure will significantly reduce lifetime.	No – very small effect
- 300-mK temp. control implementation is not clear	Agree
- 300-mK strap programme is much less mature than it should be	Agree

6. Instrument development schedule and model programme are still very tight
   - FPU structure still on critical path
   - Shedule for integration, testing and calibration is too compressed
   - Very small margin in need date for cryo-vibration facility

   Agree. These are all serious problems.

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Highlights of IIDR Board Report

7. DRCU desing is lagging behind. PSU procurement spec. must be frozen soon.
   Agree. Addressing DRCU schedule is high priority for Project Team and SAp. PSU spec. to be finalised by next week.

8. Other points

- Need to define cryoharness	Agree!
- Instrument-specific OBSW (esp. autonomy) not addressed yet	Agree
- Progress on IID-B but more needed	Agree
- Calibration requirements need to be written as formal document	Agree
- Bolometer optimisation depends on background	Agree (see later)
- Possible stray light impact of optical encoder	Agree
- EMC issues not yet properly addressed	Agree, but . . .
- More control needed over system budgets, margins	Agree
- Sensitivity to microvibrations needs to be studied	Agree

9. Internal reporting and monitoring of subsystems is still not satisfactory

   Agree. Improvement needed and there are no valid excuses.

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Highlights of IIDR Board Report

10. Board notes option to make small changes to photometer and FTS bands. SPIRE is urged not to let this deflect attention from critical issues.

    Agree.

11. Schedule is needed showing how and when parallell and serendipity modes will be settled before the end of the year.

    Parallel mode issue can’t be decided on that timescale. It is baselined and should remain so.

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Conclusions of IIDR Board Report

1. Good progress but more needed, and several important issues to be addressed for the IBDR

2. Delta-IIDR not deemed appropriate

3. IIDR Board is satisfied with SPIRE response to System Design Review Board report except for PA activities

4. Review documention should be produced on time in future

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Toledo Symposium: *The Promise of FIRST 12-15 December 2000*

- Aims
  - Announce FIRST/Herschel and its capabilities to the community
  - Identify areas where the impact of Herschel will be the greatest
  - Consider large ‘key’ vs. smaller ‘traditional’ programmes
  - Establish complementarity to other facilities

- Conclusions
  - Well attended with strong focus on Hershcel’s unique scientific capabilities
  - Review and endorsement of core science objectives
    - Extragalactic, galactic, solar system
  - Strong support for importance of large programmes
    - Mechanisms for implementation will need to defined by the Herschel Science Team
    - Astronomical community needs to recognise different mode in which Herschel will need to be operated

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Toledo Symposium: *The Promise of FIRST*

- **Some important points**
  - Limitations of confusion for deep surveys (SIRTF and Herschel)
  - Importance of SIRTF and Astro-F databases as catalogues for Herschel programmes
  - Complementarity to SIRTF, Astro-F, NGST, ALMA, Planck, 10-m class ground-based telescopes
  - Need for rapid and well organised follow-up during Herschel lifetime
  - Herschel/Planck synergy
    - Scientifically well established (point sources, clusters, foregrounds)
    - Quick follow-up is critical: procedures/mechanisms need to be defined
  - Some new ideas for large/key programmes:
    - Complete survey of galactic plane with SPIRE (360^{o} x 5^{o})
    - SPIRE survey of Planck deep survey area (400 sq. deg.; 100 mJy)
    - Systematic study of normal galaxies

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Current SPIRE Priorities

- Immediate technical issues
  - JFET dissipation and system-level thermal modelling
  - Finalise DCU design and grounding scheme
  - FPU qualification vibration levels and requirements on subsystems
- Work on schedule/AIT with Alcatel + ESA (meeting in July)
- Work on spacecraft interfaces with Alcatel
- Sequence of SPIRE DDRs leading to IBDR at end of 2001
- Maintain schedule by close monitoring of critical path subsystems
- Improve and formalise Project Management
- Consider options for GT use

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Critical Areas and Challenges

- Stray light minimisation and prediction
  - Potential problem with any low background instrument
  - Systems issue - involves telescope provider, satellite Prime Contractor, ESA, and three instrument teams
- FPU mechanical/thermal engineering
  - STM programme will provide early verification of performance and mitigate risk
- Mechanisms (esp. FTS)
  - FTS mechanism is challenging with stringent specifications
  - Problems with flex pivot procurement
- Schedule and overall AIT programme for the Herschel satellite
  - SPIRE has issued discussion note on this
- Avoiding a budget-driven descope
  - BSM
  - Flight Spare integration and test

Instrument Design Update

Bruce Swinyard
RAL

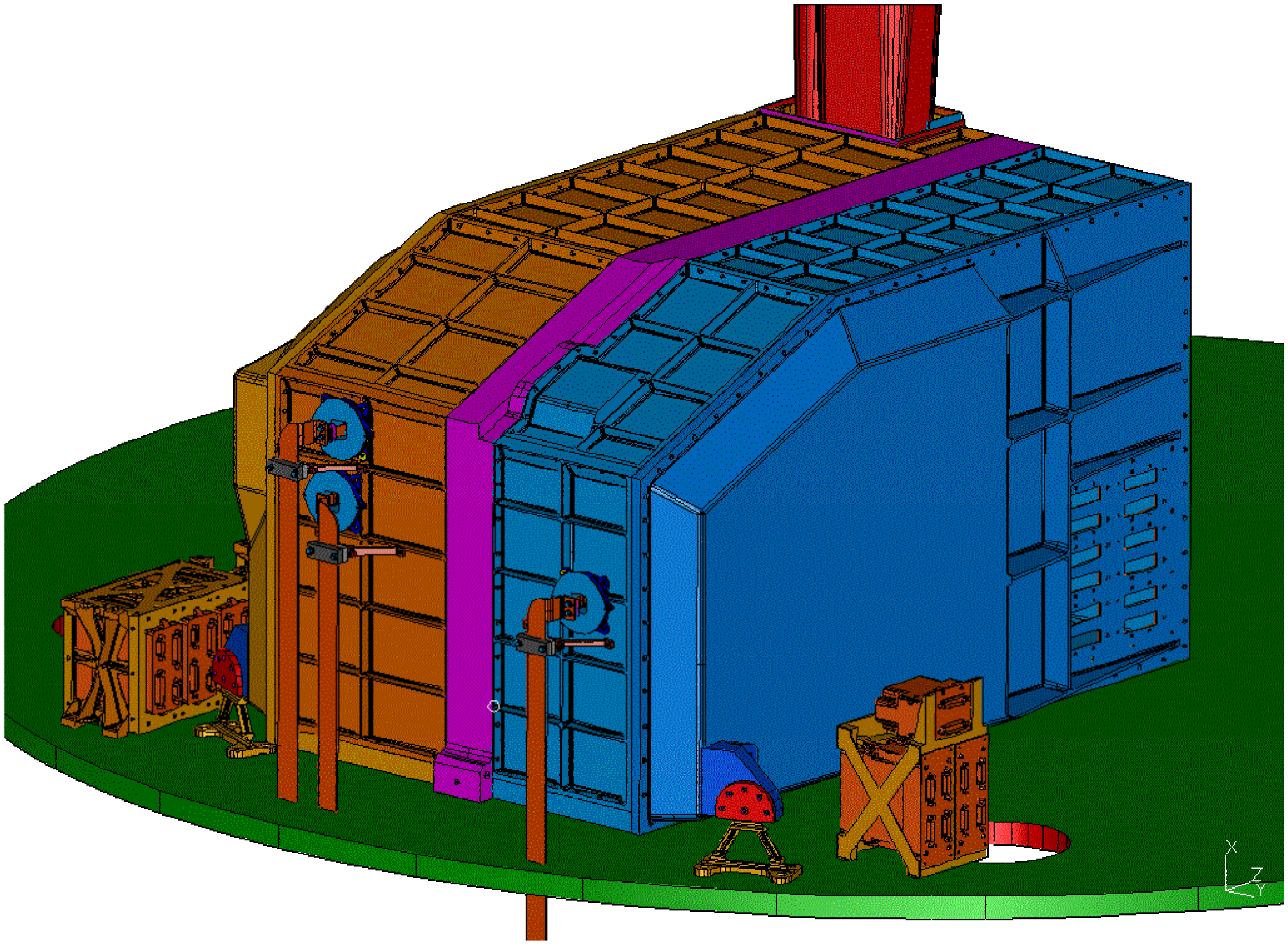
Overview

- Instrument baseline design is essentially complete in almost all areas
- Subsystems will complete detailed design reviews by October 2001 ready for ESA Instrument Baseline Design Review in late 2001
- Detailing the design has led to some compromises in certain performance criteria and more may necessary……
- In this talk I will highlight where the performance of the instrument is "under pressure" from the real world for both the subsystem implementation and at the global instrument level

Topics to be addressed

- Overview of the instrument design and subsystem implementation
- More in depth look at three critical cold subsystems:
  – Bolometer Detector Arrays (BDAs) - with reference to the instrument thermal design
  – Beam steering mirror
  – Fourier Transform Spectrometer and specifically the Spectrometer Mechanism (SMEC)
- A description of how the electronics is configured; how the detector amplifier chain works and how how the instrument will be commanded
- A brief look at the system level problems identified in discussion with Alcatel

Instrument Overview
(covers on)



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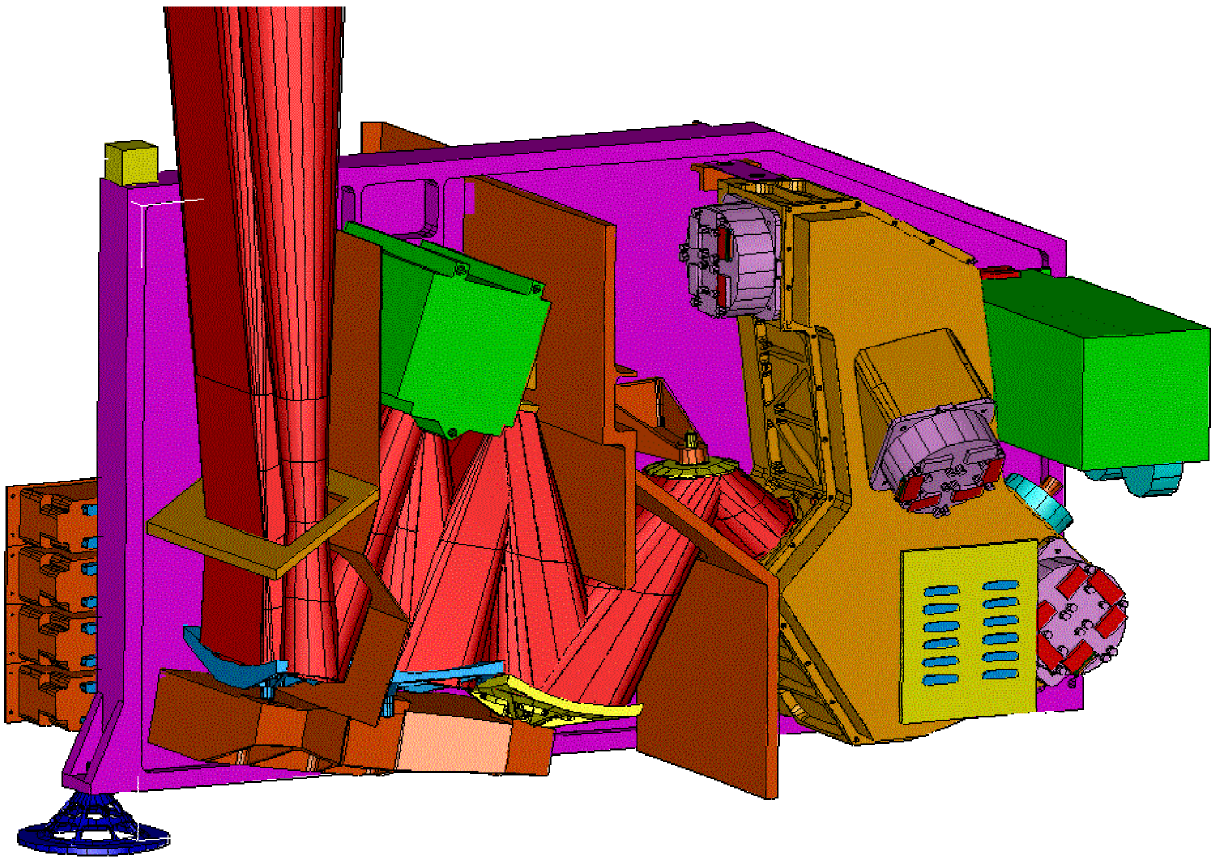
Instrument Overview

(Photometer)



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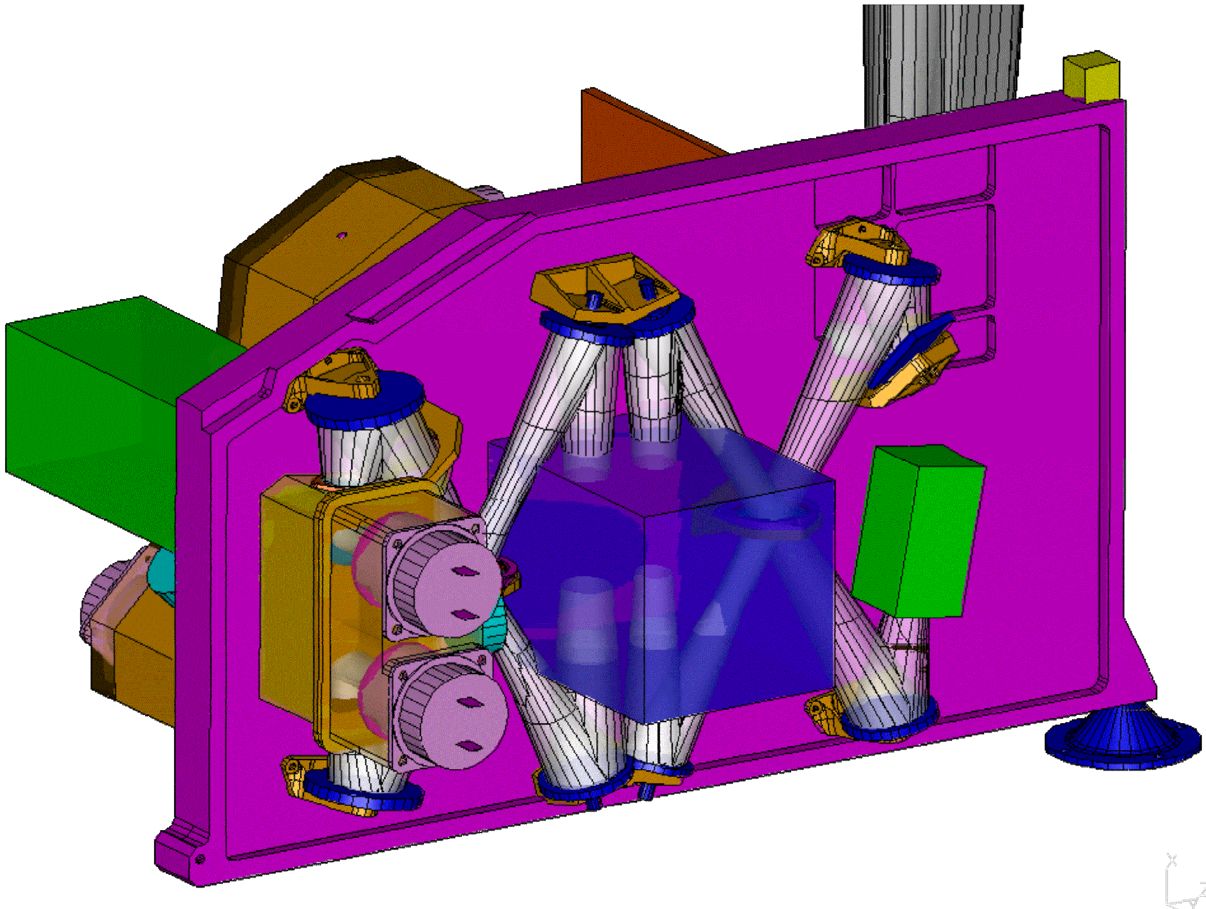
Instrument Overview

(Spectrometer)



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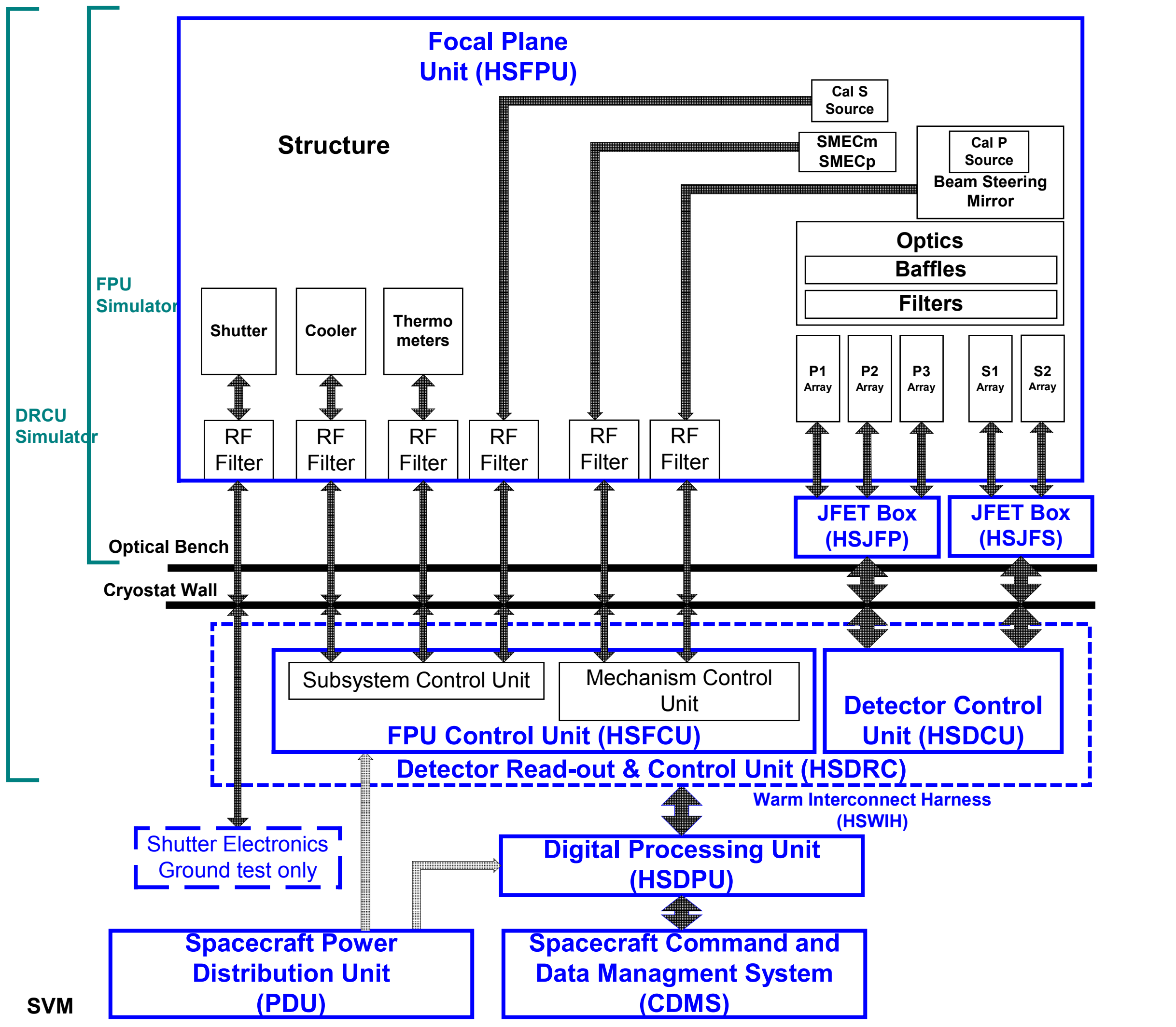
Block Diagram



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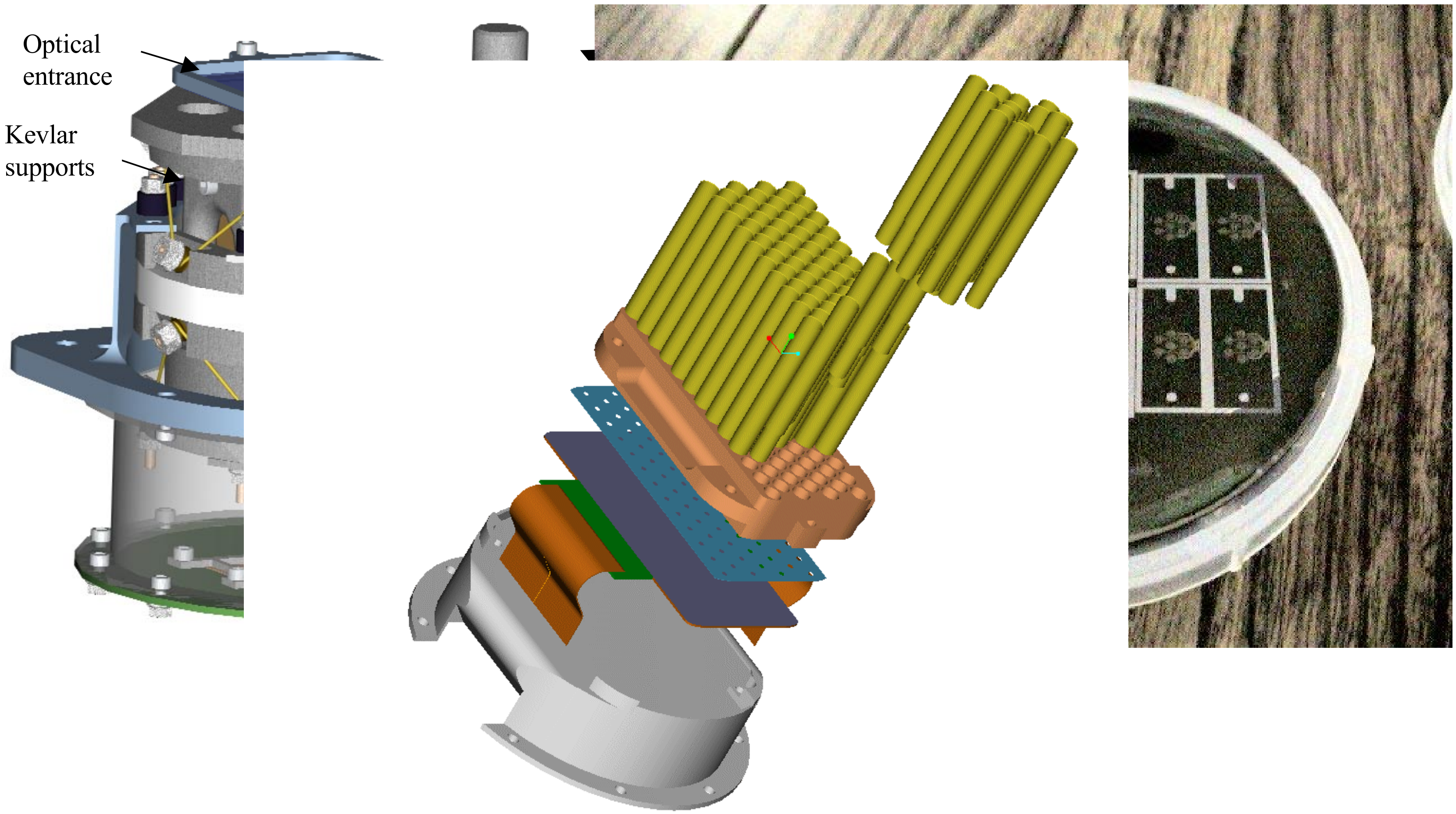
Bolometer Detector Arrays



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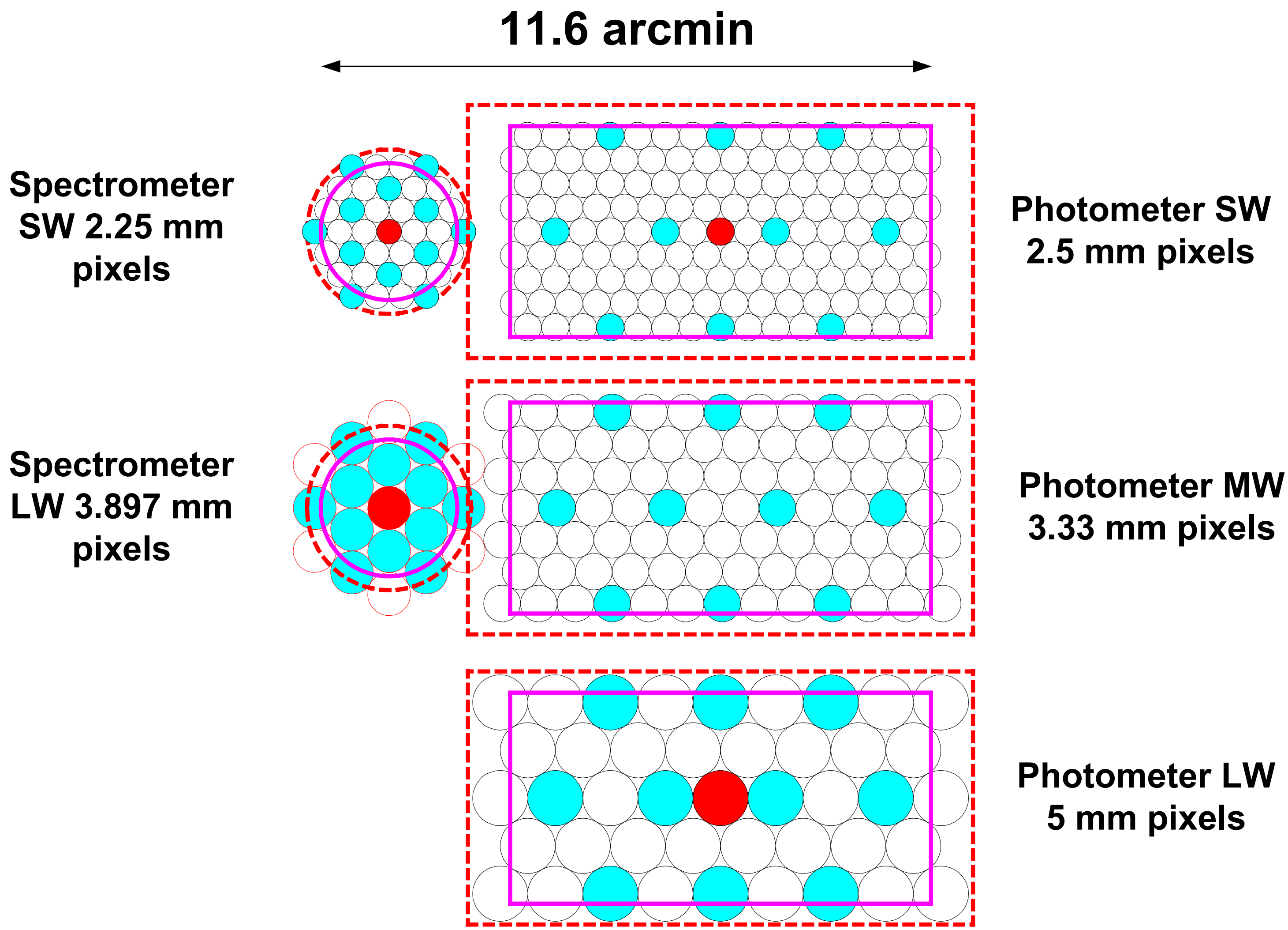
Pixel Layouts



Proposed Wavelength Bands

Array	λ_o (μm)	λ_U (μm)	λ_L (μm)	$\lambda/\Delta\lambda$
P/SW	250	209	291	3.05
P/MW	350	292	408	3.02
P/LW	500	418	583	3.03
S/SW	275	200	355	1.79
S/LW	450	345	670	1.56

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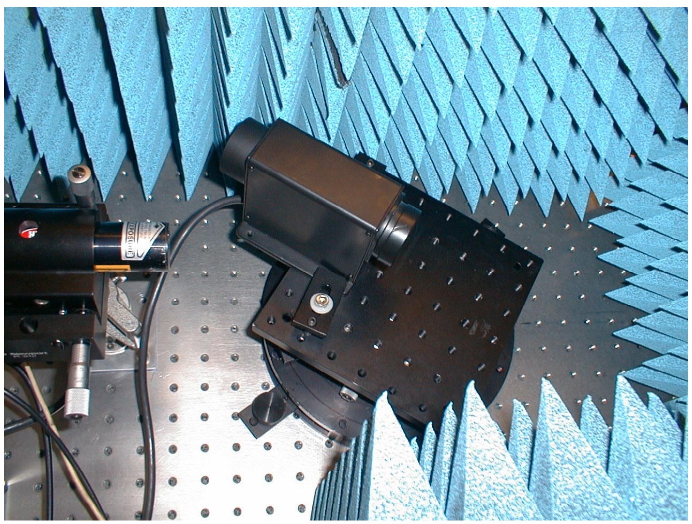
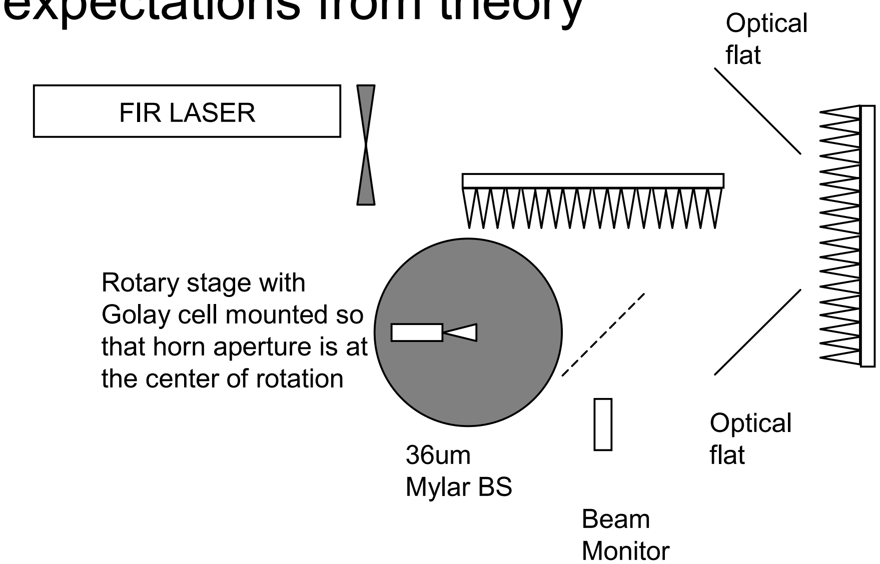
Impact of Changes to Spectrometer Bands

- Makes the LW feedhorn/backshort design very much easier to implement over the 350-670 wavelength range
- Increases the background power in the 200-350 range and thus degrades sensitivity here (10-20%)
- Decreases the background in the 350-550 um range and thus increases sensitivity here (~30%)
- Makes the 609 line truly available to SPIRE

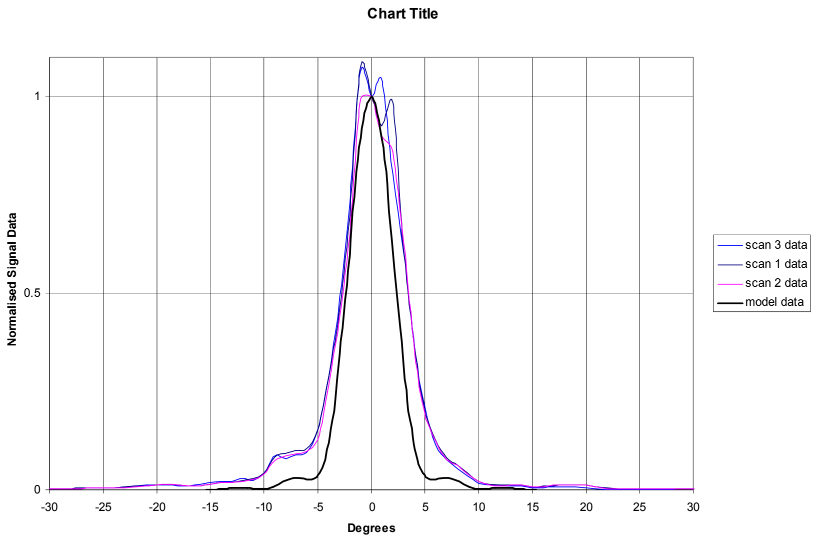
Feedhorn Measurements

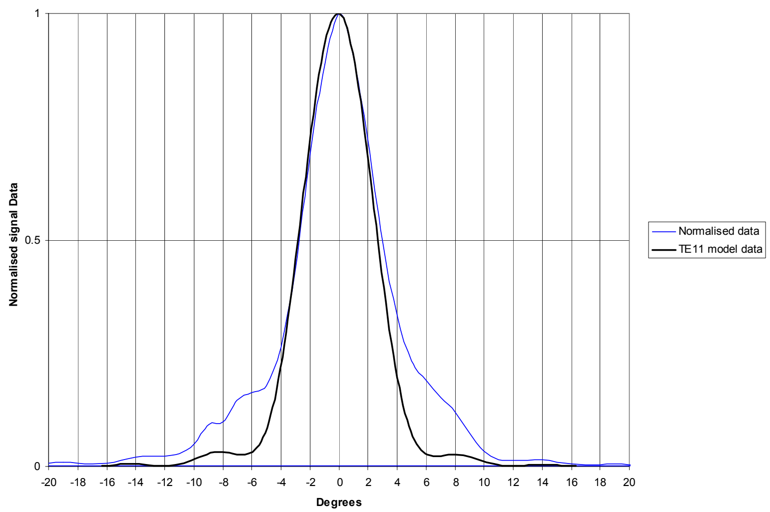
- Test programme underway at University of Colorado to compare feedhorns from different vendors
- Hiatus in programme due to teething troubles with detectors so no results (Jamie?)
- Also have done some testing of feedhorns at RAL using the FIR laser and compared to expectations from theory





Laser Results (1)





Single mode horn 250 um horn at 214 um

Two modes actually present - difference in width is explained by non-collimated laser beam

Multi-mode horn 250 um horn at 214 um

Many modes should be present - efficiency of different modes needs to be checked

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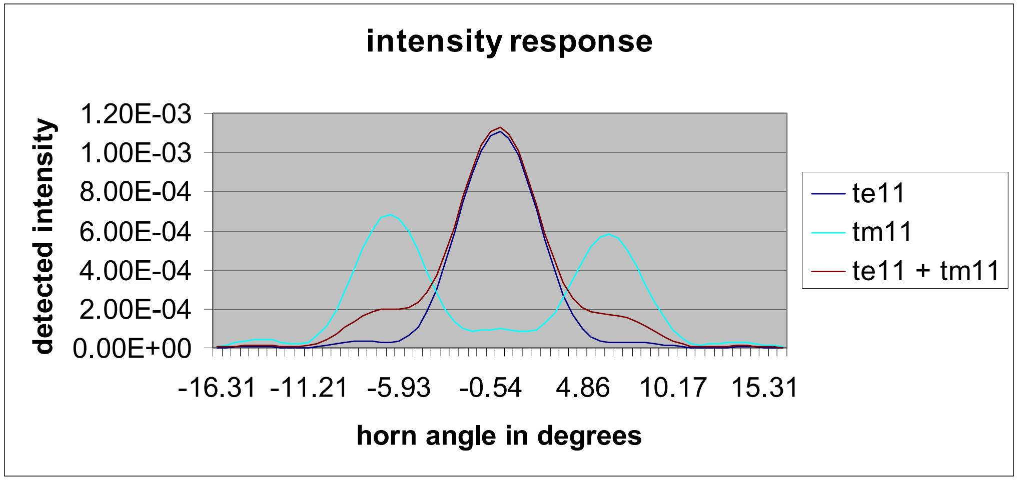
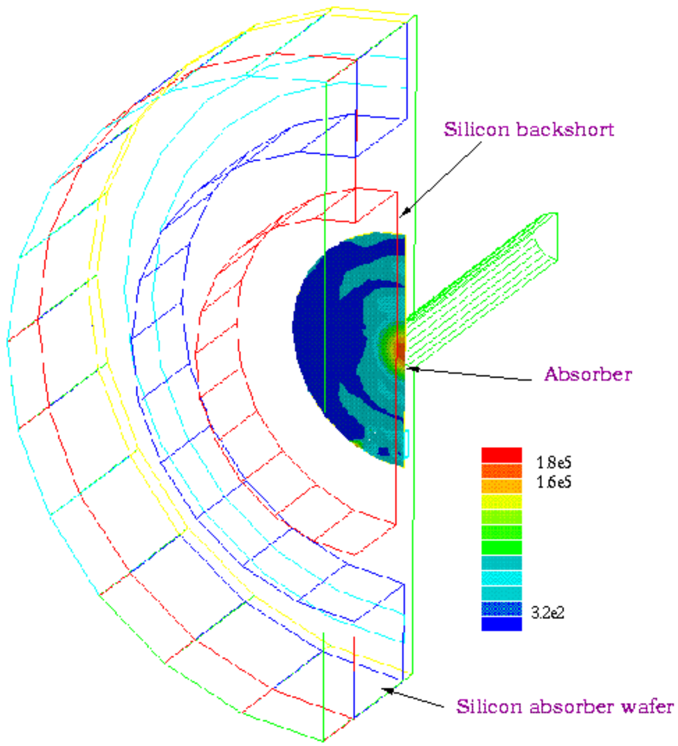
Laser Results (2)



Mode	**Relative power**
TE11	1.0
TE21	0
TM01	0
TM11	0.5

HFSS Modelling

- Caltech have been conducting a study using HFSS.
- Results show that for the single mode horns the power is concentrated towards the middle of the cavity with negligible leakage between pixels
- Doing this for multi-moded horns is more difficult (Jamie?)



Critical Areas (1) Overview

- JFET power dissipation to the ~10 K (level 2) stage in the cryostat will be problematical for the instrument stability and operating temperature
- Implementation of the straps between the cooler and the detectors is difficult and may yet cause problems with ultimate detector temperature
- Mechanical design of the BDAs is complete - BUT vibration levels now calculated for their test are too high
- The efficiency of the backshorts for the spectrometer detectors remains to be proven either by modelling or by measurement.
- The detailed design of the detector electronics chain is now ongoing. Issues have been identified with the low pass filtering and the detailed implementation of the grounding

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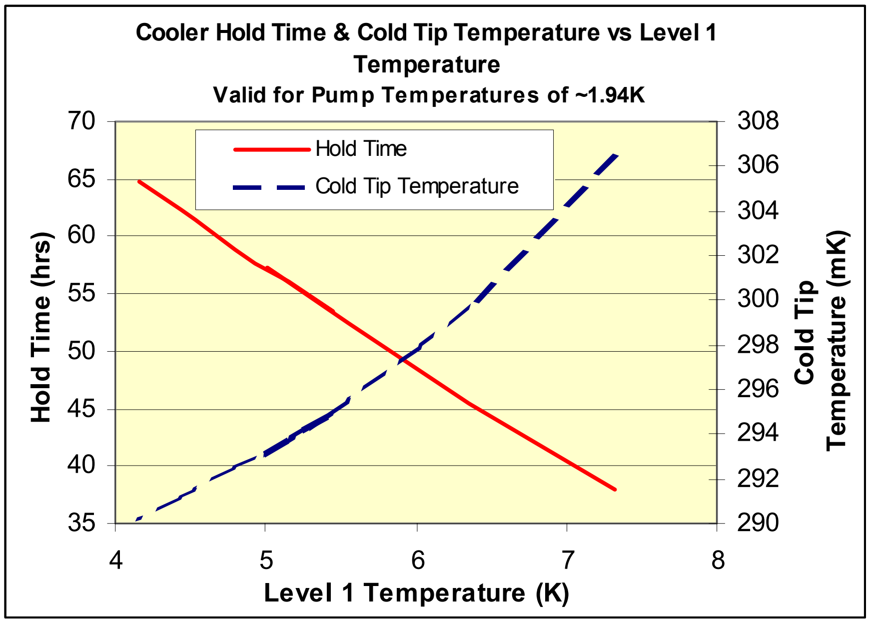
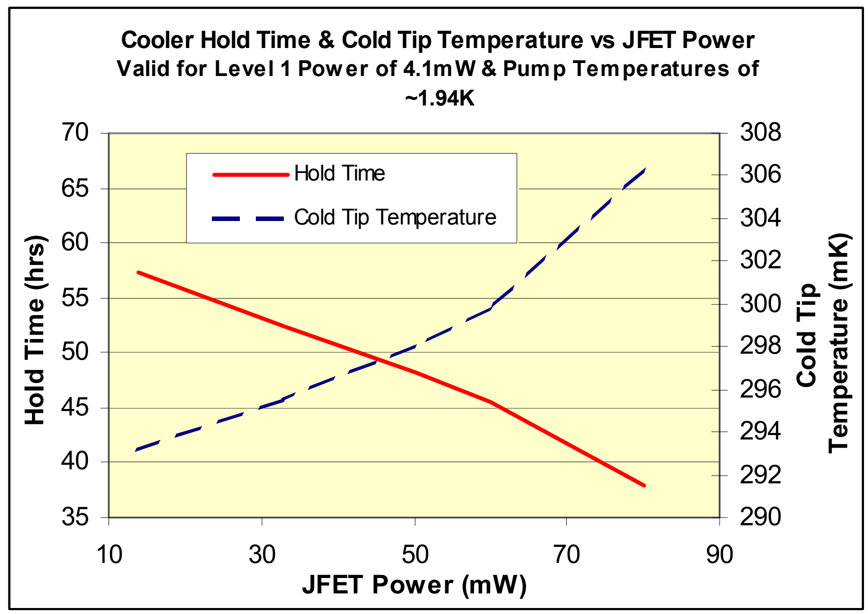
Critical Areas (2)

- Thermal design - JFETS:
  - The JFETs need to run at >100 K
  - They are mounted on insulating membranes ~2 microns thick.
  - The initial prototypes appear to require more power than predicted to get to temperature (~50-60 mW cf 33 mW)
  - System level thermal modelling shows that this will start to cause problems both with the thermal stability and ultimate temperature of the detectors
  - More detailed modelling of the JFETs and the membranes indicates that the problem maybe less severe than we thought
  - Engineering model tests should confirm this

Critical Areas (2) - thermal ctd….





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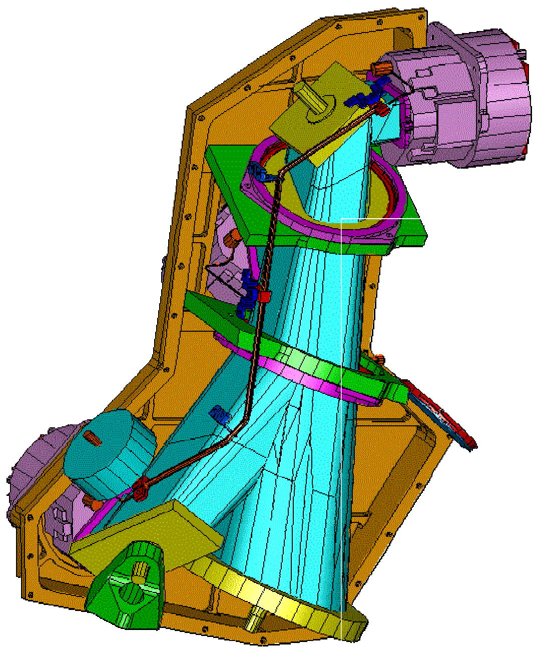
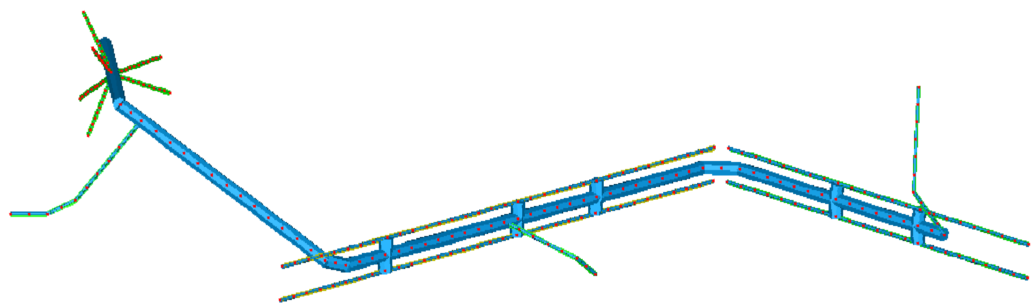
Critical Areas (3) 300 mK Strap



300 mK strap goes from the cooler cold tip to the detectors (~25 cm max)

The heat leak budget for the supports from 1.7 K is ~2 μW

It also has to survive launch



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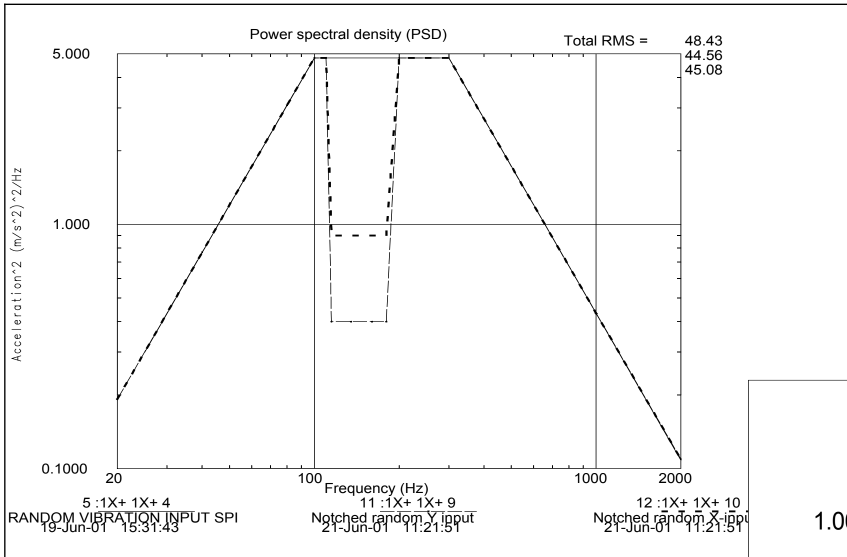
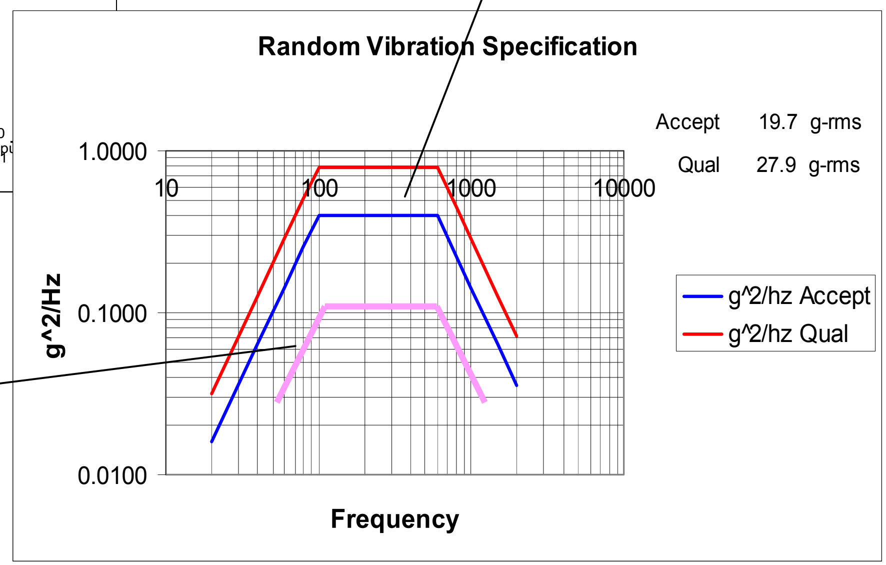
Critical Areas (4) Vibration





Berend's proposal

What the BDAs can stand

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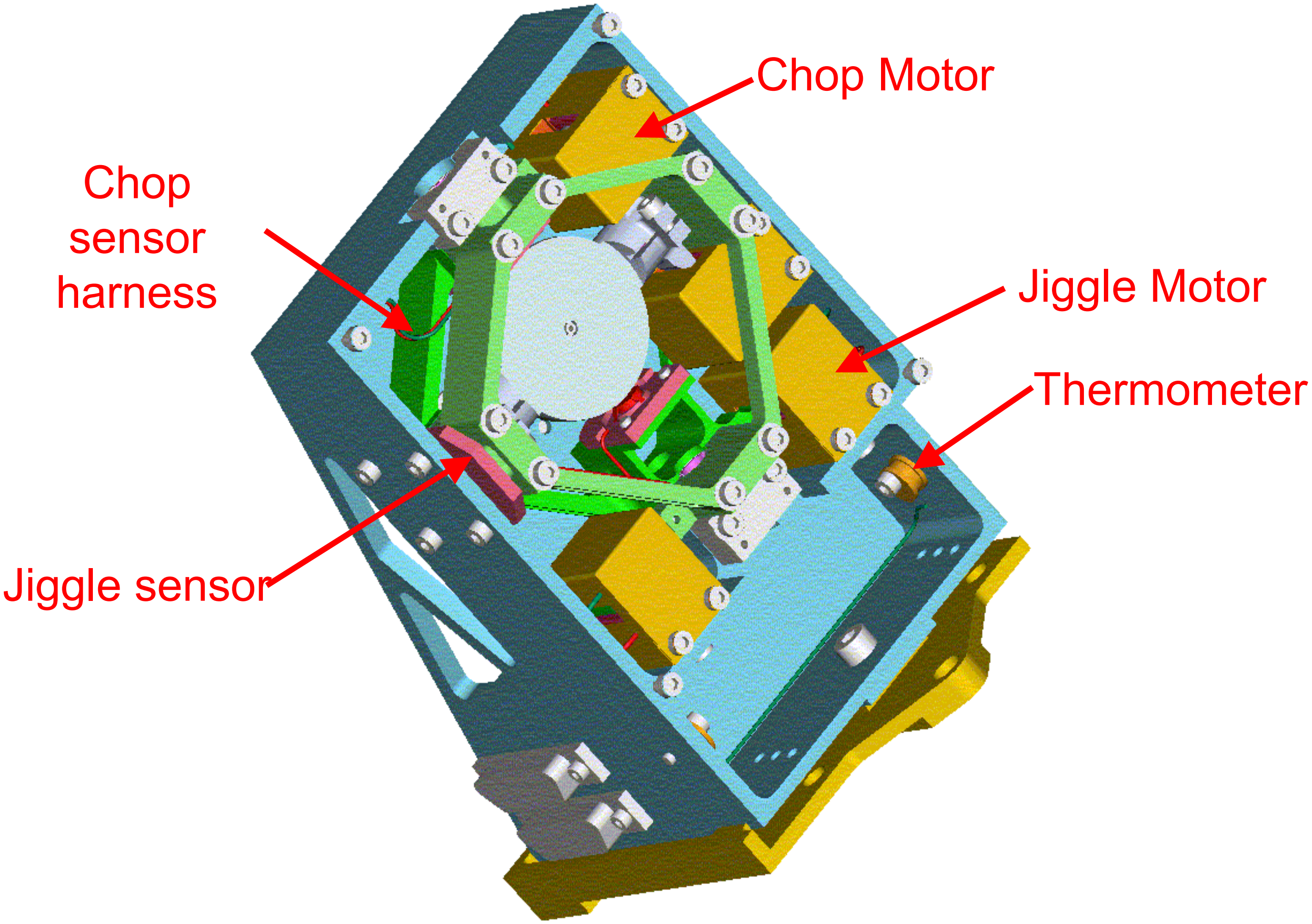
Beam Steering Mirror



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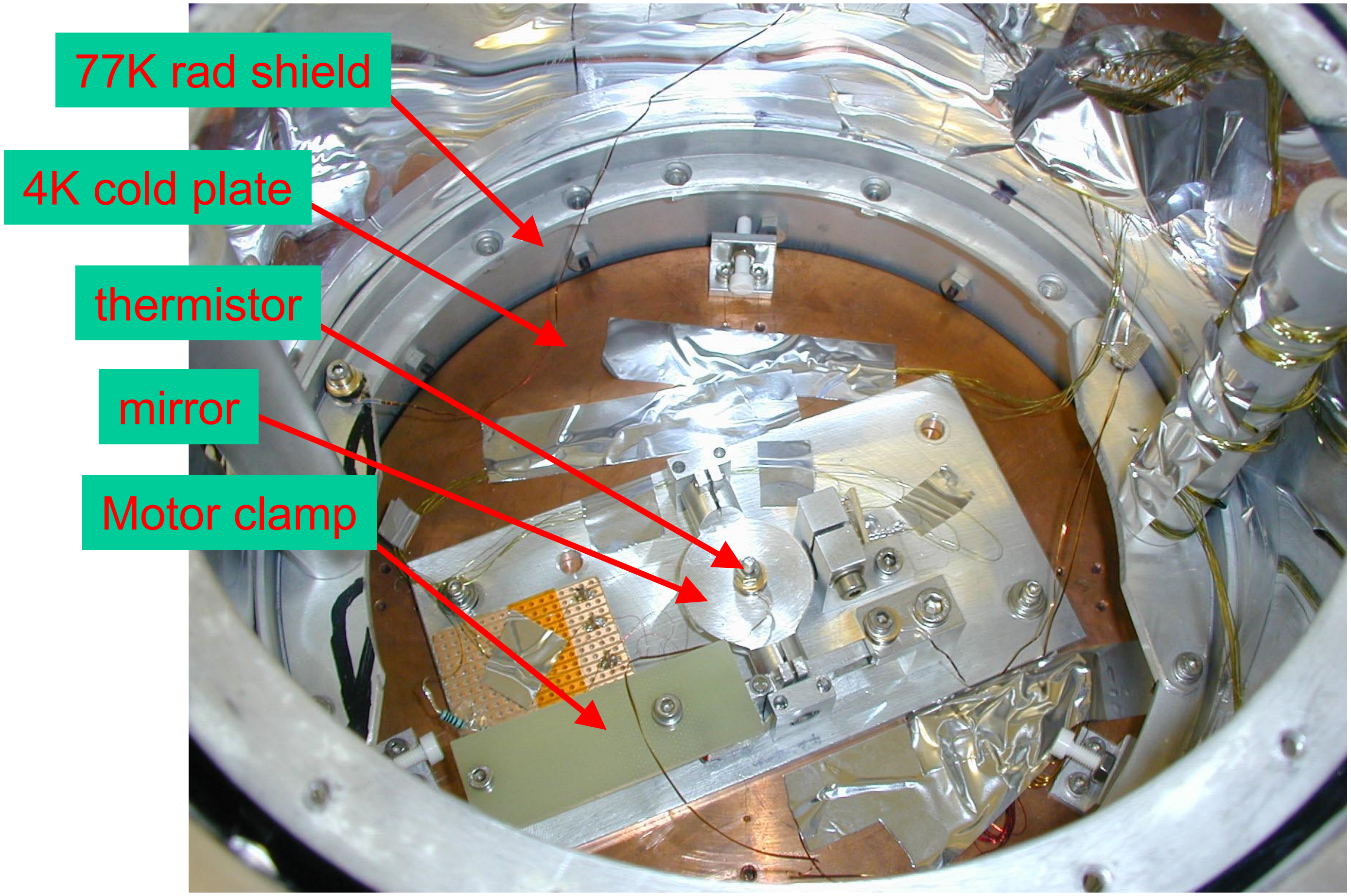
One Axis Prototype Testing



Critical Areas

- Flex pivots - thermal/power/cost problems
- Baffling

FTS/SMEC

- The spectrometer is based on a Mach-Zehnder design with a moving mirror mechanism (SMEC) giving R=0.4 cm^{-1} for $\pm$3.2 mm movement and R=0.04 cm^{-1} for -3.2 to +32 mm movement
- The mechanism is a difficult piece of engineering
- The optical design is squeezed to the absolute minimum space envelope due to the constraints of accommodation in Herschel
- The wavelength range over which we wish to operate is very broad (~3 octaves)

These issues lead to some comprises

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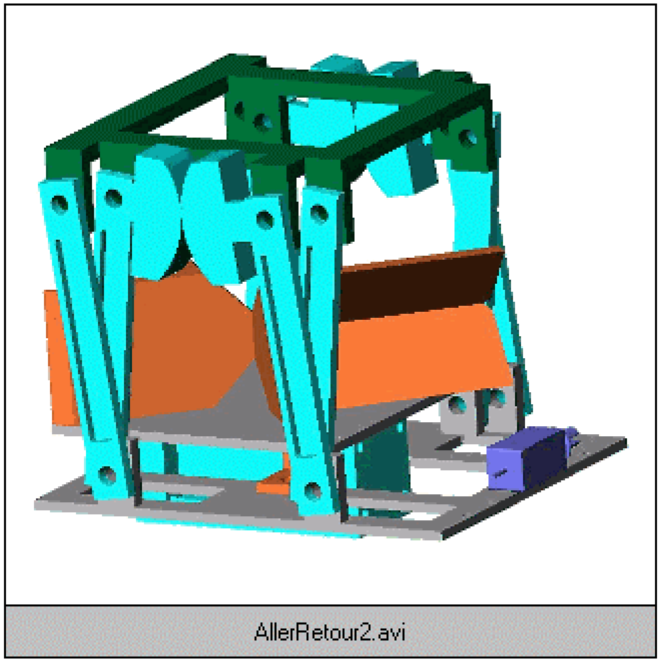
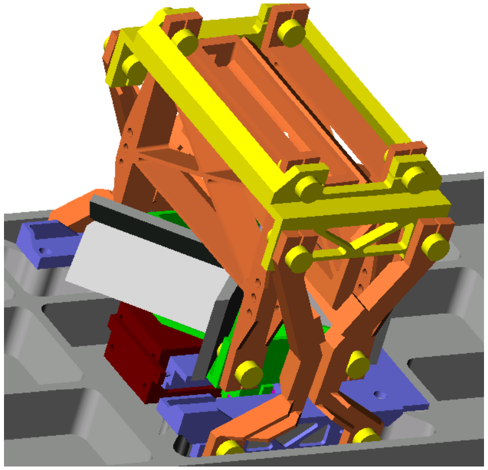
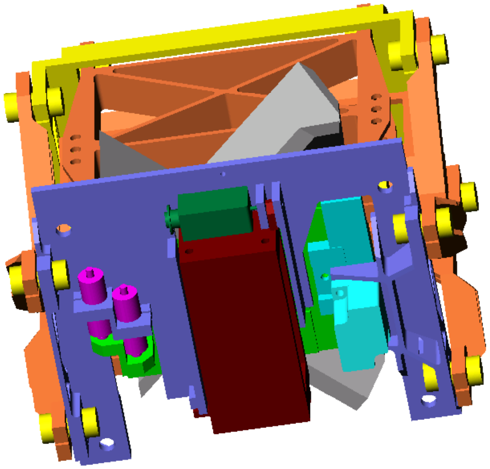
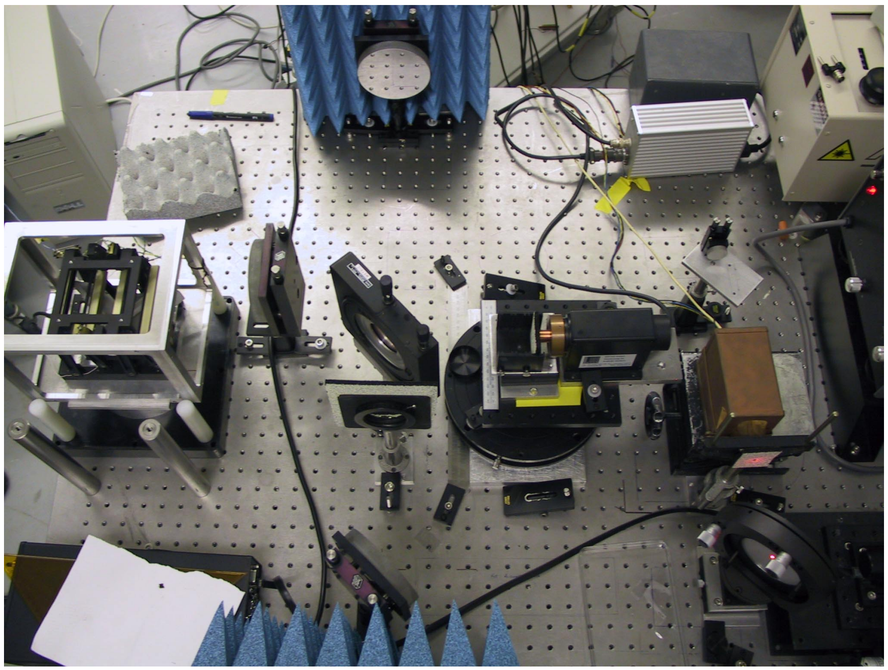
SMEC Concept/Design

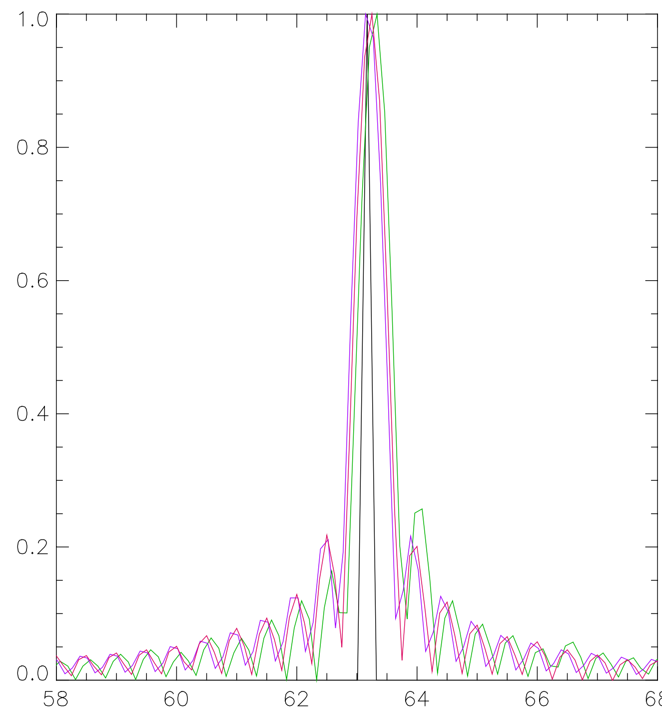






Prototype Testing





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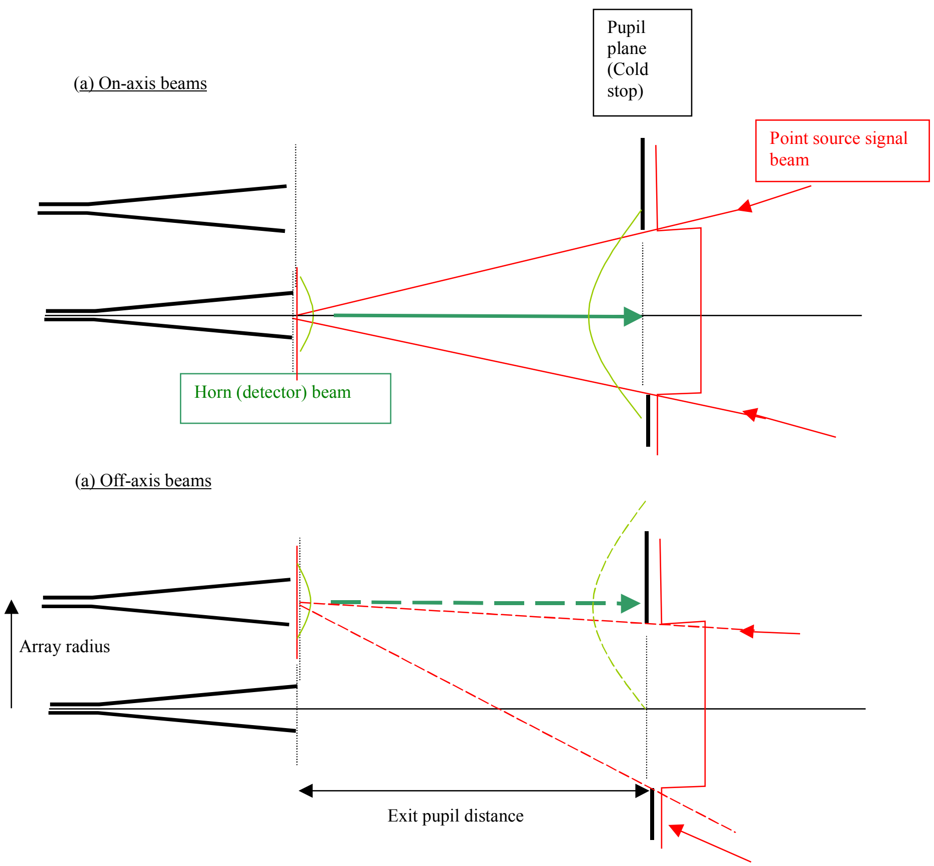
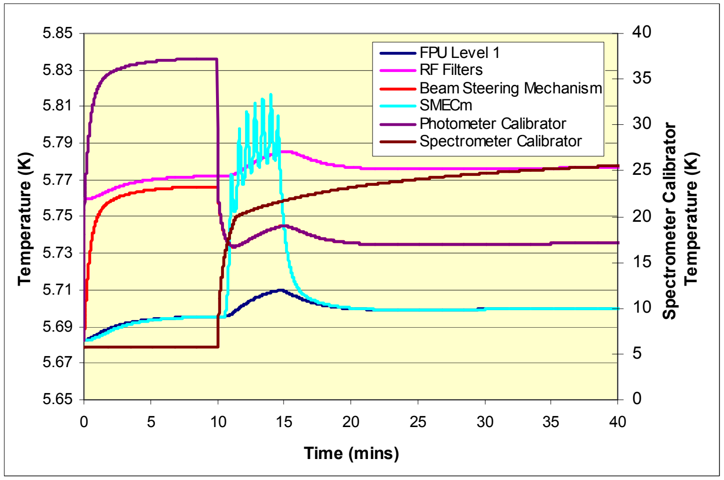
Non-Telecentricity

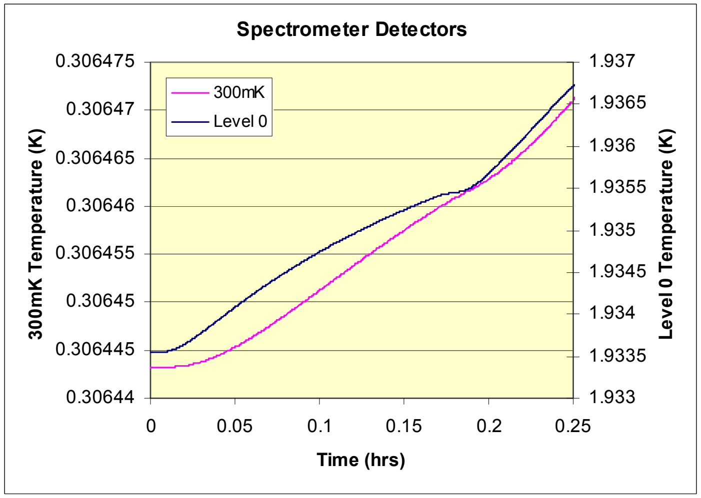


- The on-axis aperture efficiency is ~80% and the contrast ~85% at 32 mm motion
- At the edge of the FOV the aperture efficiency falls to ~55%
- There will also be a reduction in contrast due to beam shear
- The goal resolution may not be achieved over the whole FOV

SMEC Critical Areas

- SMEC performance
- Encoder Straylight
- Vibration Levels
- Thermal problems
- Restriction on movement/operations





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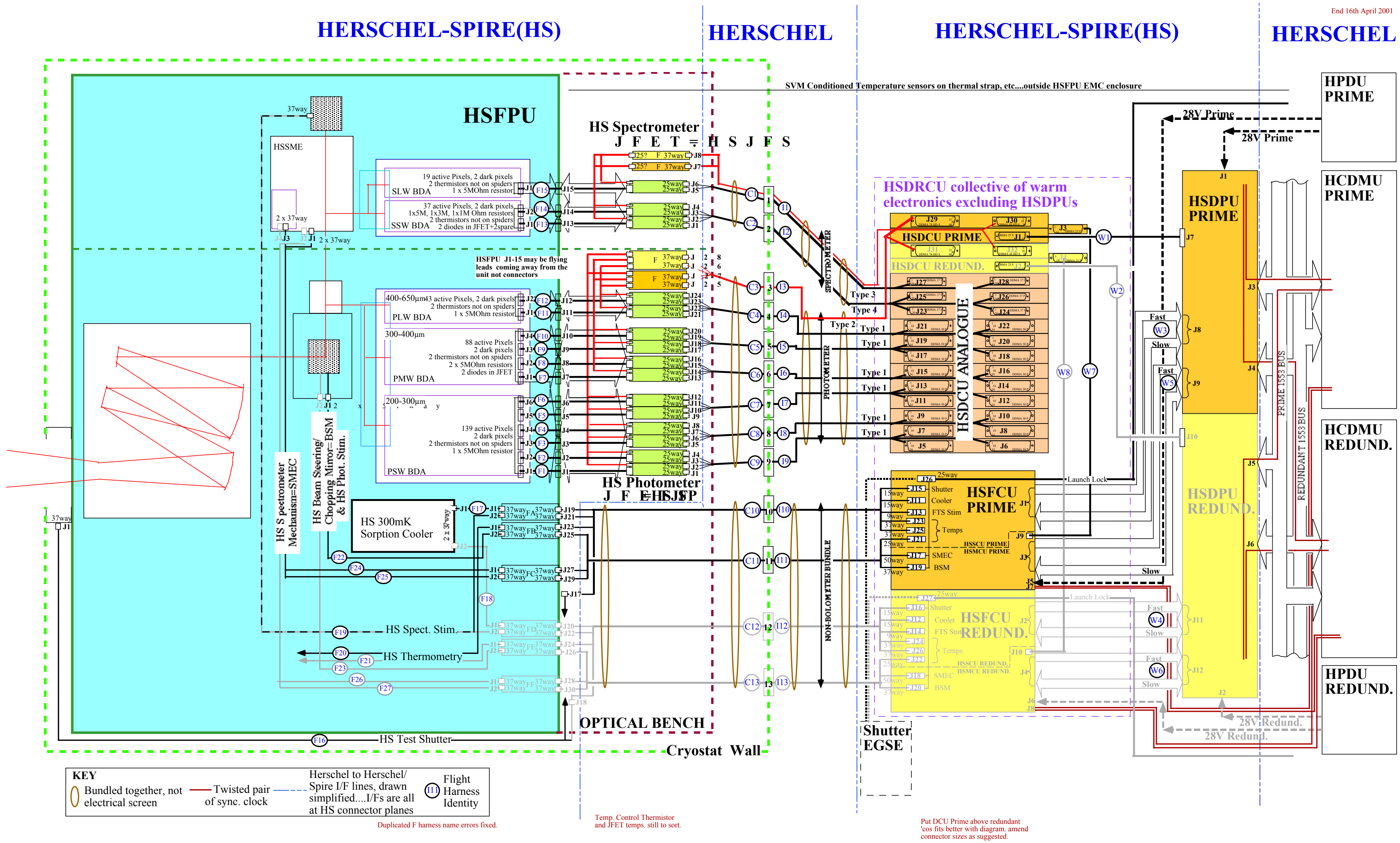
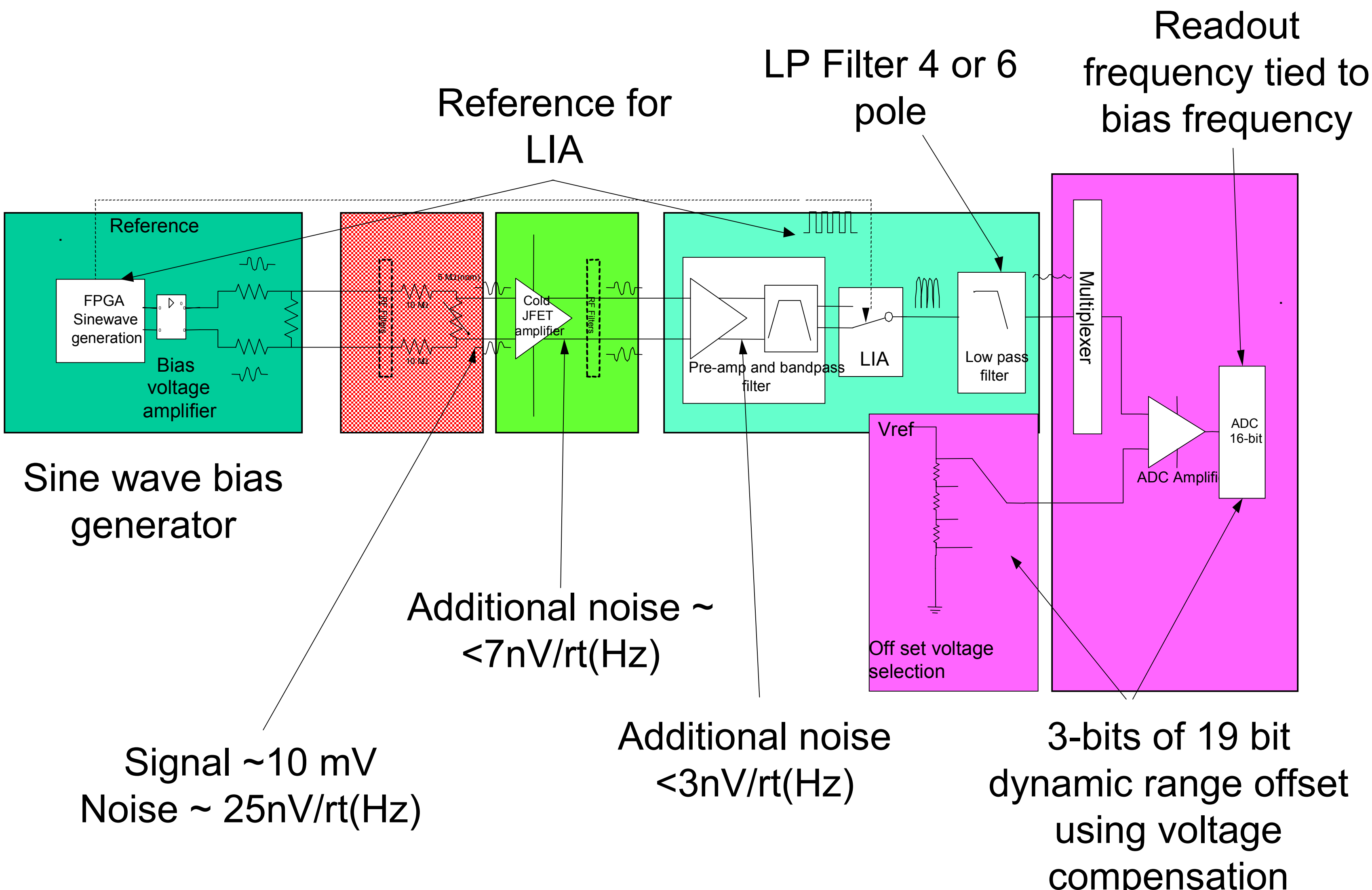
Electronics Overview



Detector Electronics Chain



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Instrument/Satellite Level Issues

- Cold dissipation - too much but system level budget in IID-A is not well defined!
- Mass - 9.5 kg over allocation - we will be asked to curtail this
- Electrical Power - 17 W over allocation - probably not really a serious problem
- Telescope design - this is now SiC - restriction on manufacture may lead to design compromises - we await developments

SPIRE

SPIRE Scientific Capabilities

- **Review of observing modes**
- **Sensitivity models and results**
    - **Assumptions**
    - **Methods**
    - **Results**
    - **Uncertainties**
    - **Limitations on observable flux density**
        - **Linearity (bright end)**
        - **Confusion (faint end)**
- **Choice of FTS bands**
- **Unpredictable background power – implications for bolometer design**
- **Choice of photometer bands**

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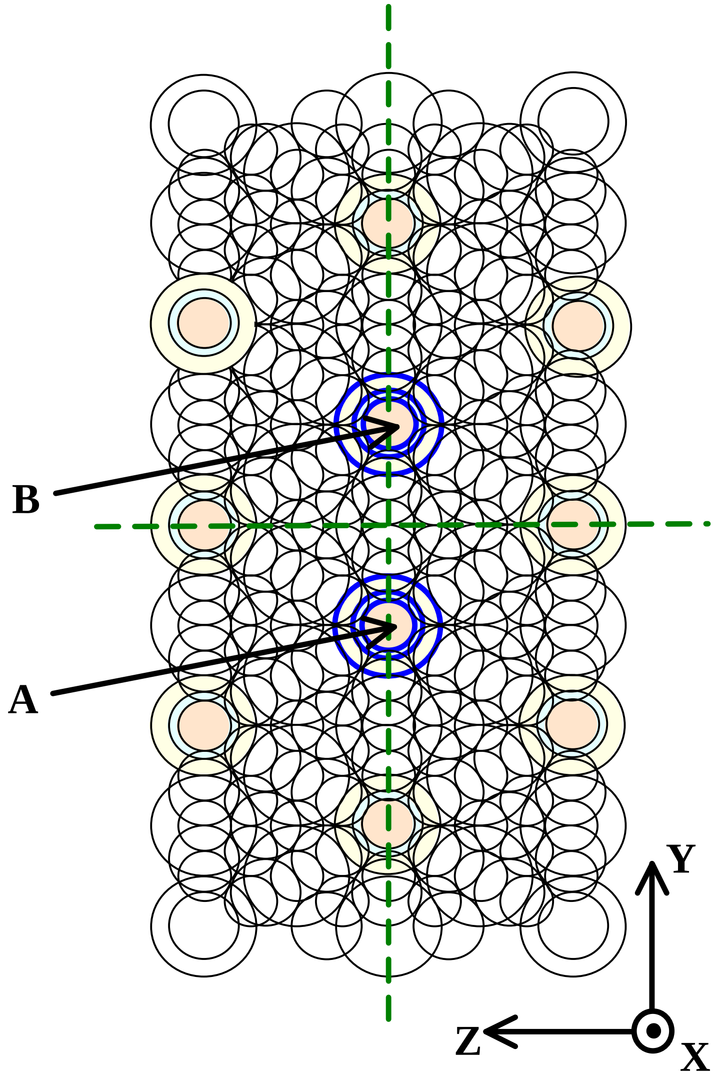
Point Source Photometry

- **Telescope pointing fixed**
- **Chopping in Y-direction between A and B (126”)**
- **Simultaneous observation in the three bands with two sets of co-aligned detectors**
- **Chop without jiggling is OK if the pointing is goal is met (< 2”)**



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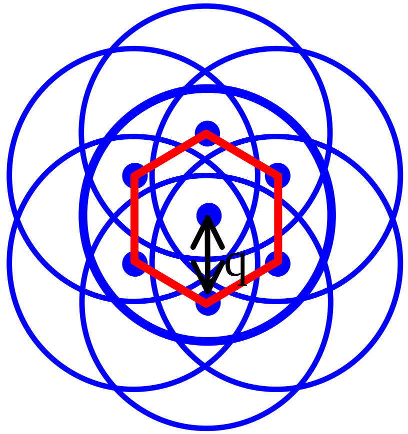
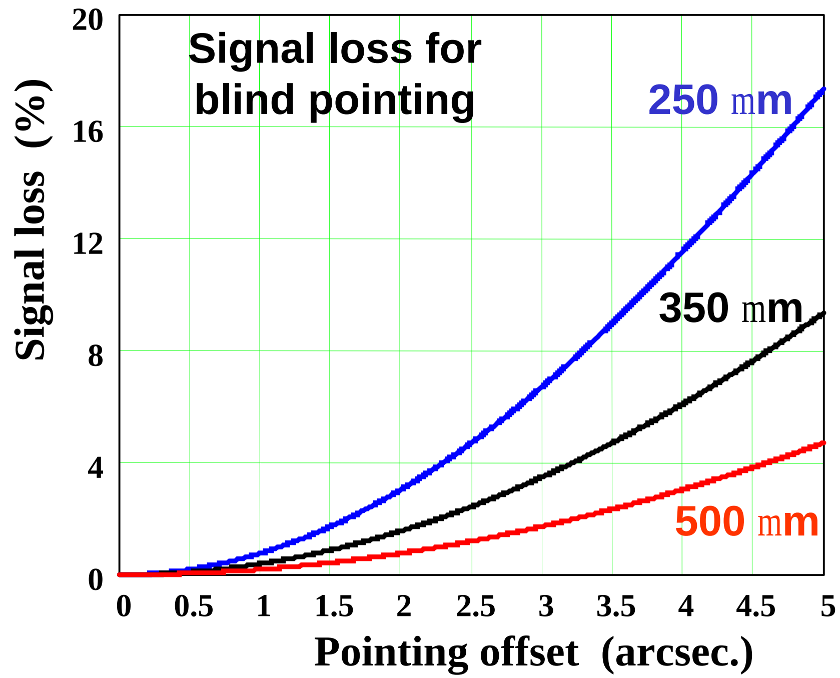
7-point Jiggle Map

- Chopping 126”
- 7-point jiggle pattern
- Angular step q ~ 4 - 6 arcseconds (> pointing or positional error)
- Total flux and position can be fitted
- Compared to single accurately pointed observation, S/N for same total integration time is only degraded by

~ 20%	at	250 mm
~ 13%	at	350 mm
~ 6%	at	500 mm





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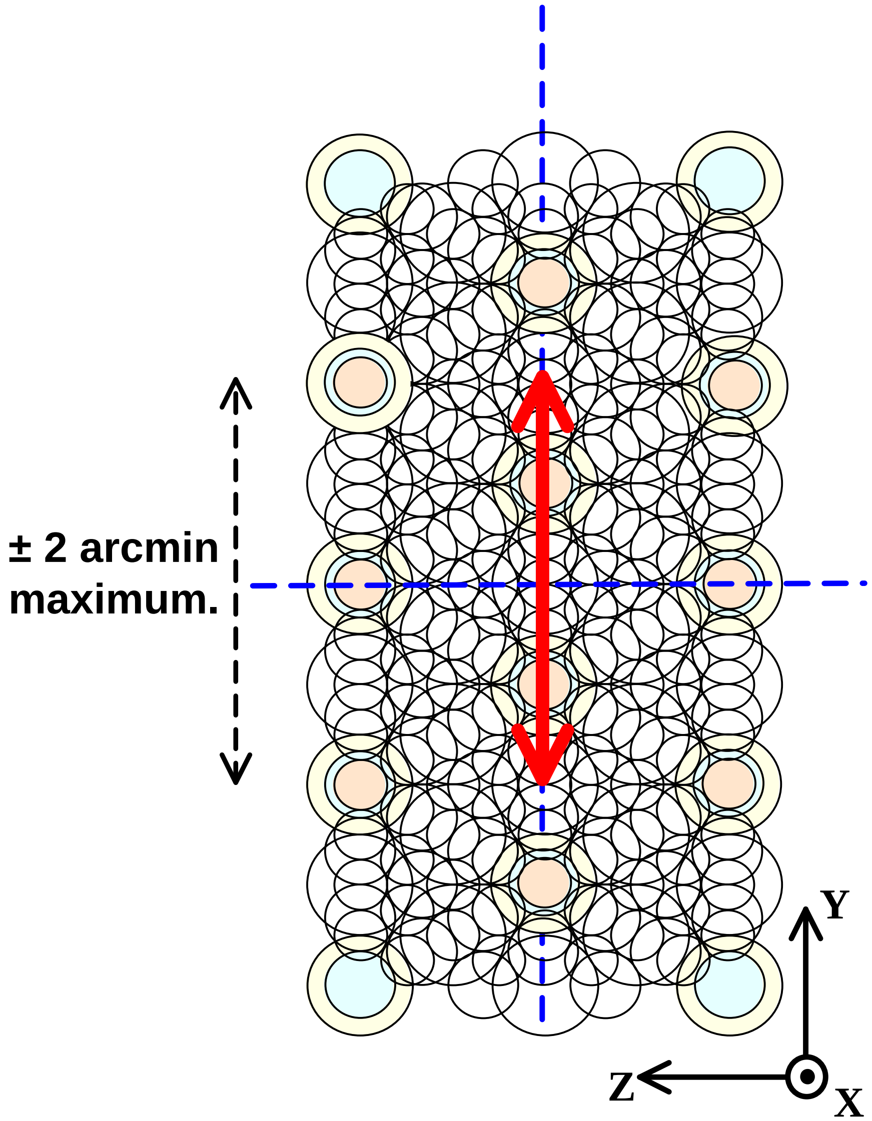
Field Mapping

- **Telescope pointing fixed or in raster mode**
- **Chopping up to 4 arcmin amplitude in Y direction**
- **64-point "jiggle" pattern for full spatial sampling**



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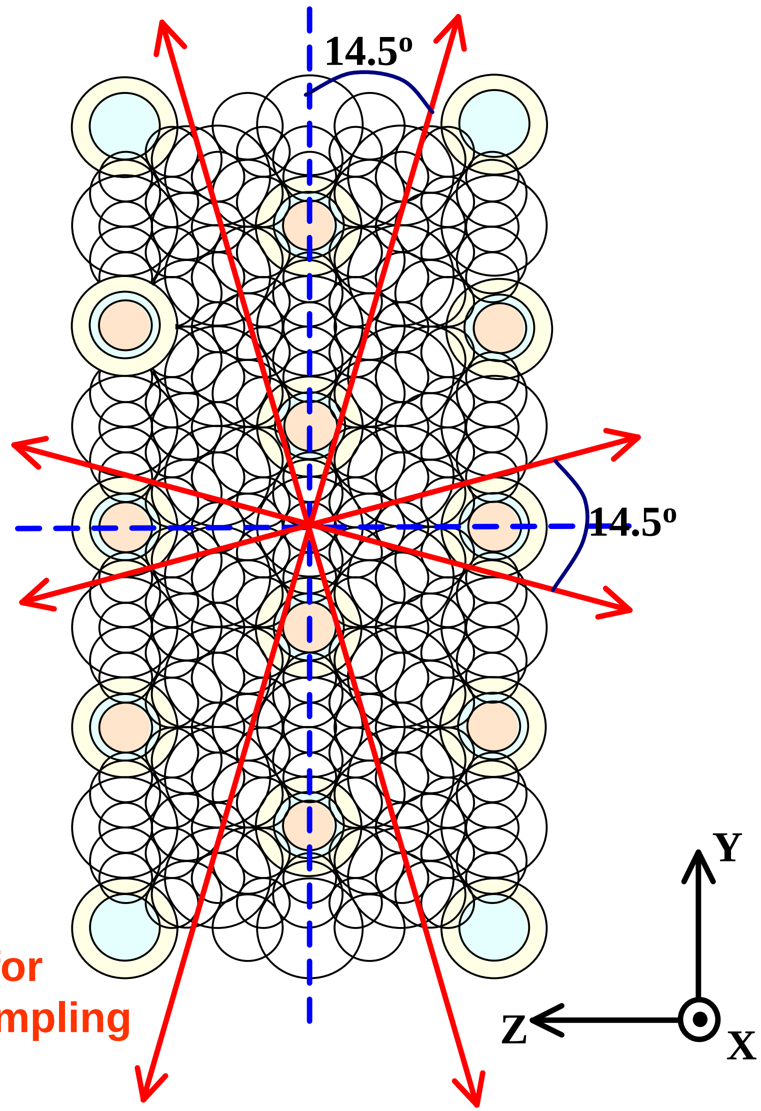
Scan Mapping

- **Telescope in line scanning mode**
- **Scan rate ~ 20-30"/sec.)**
- **Map of large area is built up from overlapping parallel scans**
- **Most efficient mode for large-area surveys**



Scan directions for instantaneous full sampling

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Instrument Sensitivity - Assumptions

Telescope/System

Temperature (K)	80
Emissivity	0.04
Used diameter (m)	3.29
No. of observable hours per 24-hr period	21
Observing efficiency (slewing, setting up, etc.)	0.9

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Instrument Sensitivity - Assumptions

Photometer

Bands (μm)		250	350	500
Numbers of detectors		139	88	43
Beam FWHM (arcsec.)		17	24	35
Bolometer DQE w.r.t. absorbed power		0.6	0.7	0.7
Throughput (single-moded)		λ^2		
Bolometer yield		0.8		
Feedhorn coupling efficiency to point source		0.7		
Feed-horn/cavity efficiency		0.7		
Field of view (arcmin.)	Scan mapping	4 x 8		
	Field mapping	4 x 4		
Overall instrument transmission		0.3		
Filter widths ($\lambda/\Delta\lambda$)		3.3		
Chopping efficiency factor		0.45		
Reduction in telescope background by cold stop		0.8		

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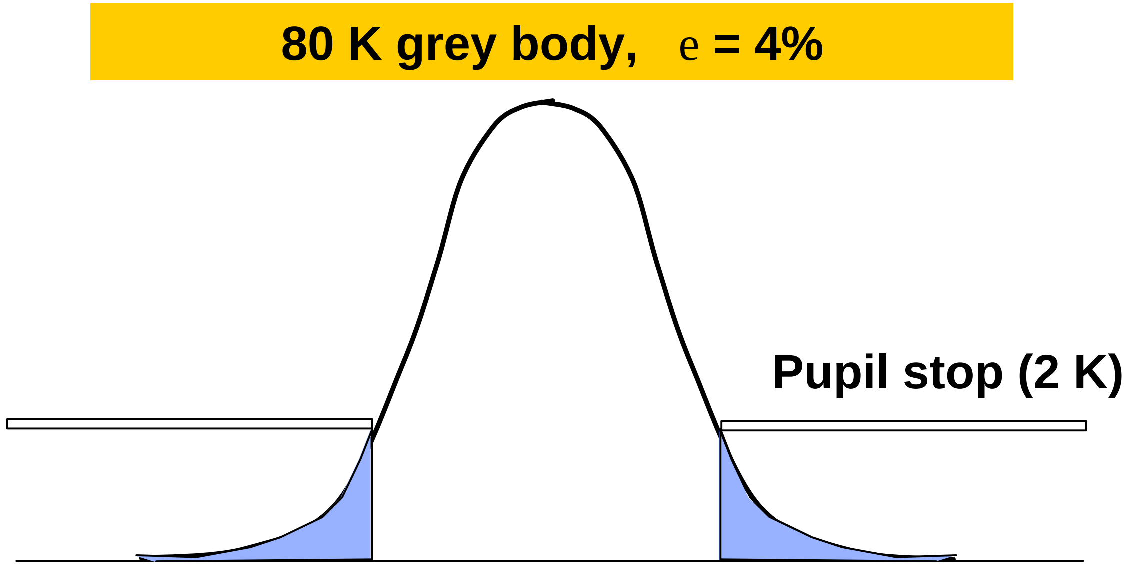
Instrument Sensitivity - Assumptions

Fraction of horn throughput that sees telescope background = 0.8



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Instrument Sensitivity - Assumptions

Detective Quantum Efficiency (DQE)

$$\mathbf{NEP_{tot}} = \left[\mathbf{NEP_{ph}}^2 + \mathbf{NEP_{det}}^2\right]^{1/2}$$

For a given background power, observing speed scales with DQE

$$\mathbf{DQE} = \left[\frac{\mathbf{NEP_{ph}}}{\mathbf{NEP_{tot}}}\right]^2$$

$\lambda_i =$	$DQE\_min_i :=$	$DQE\_goal_i :=$	$DQE\_nom_i :=$
250	0.55	0.66	0.6
350	0.61	0.73	0.7
500	0.66	0.79	0.7

Feedhorn/cavity efficiency

$\eta feed\_min := 0.45$ $\eta feed\_goal := 0.85$ $\eta feed\_nom := 0.7$

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Instrument Sensitivity - Assumptions

Detective Quantum Efficiency (DQE)

$$\mathbf{NEP_{tot}} = \left[\mathbf{NEP_{ph}}^2 + \mathbf{NEP_{det}}^2\right]^{1/2}$$

For a given background power, observing speed scales with DQE

$$\mathbf{DQE} = \left[\frac{\mathbf{NEP_{ph}}}{\mathbf{NEP_{tot}}}\right]^2$$

Photometeter

$\lambda_i =$	$DQE\_min_i :=$	$DQE\_goal_i :=$	$DQE\_nom_i :=$
250	0.55	0.66	0.6
350	0.61	0.73	0.7
500	0.66	0.79	0.7

Spectrometer

	$DQE\_min_b :=$	$DQE\_goal_b :=$	$DQE\_nom_b :=$
LW	0.61	0.73	0.65
SW	0.66	0.79	0.65

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Instrument Sensitivity - Assumptions

FTS

Bands (mm)	Nominal	200-300	300-670
	Proposed	200 - 355	345 - 670
Numbers of detectors		37	19
Bolometer DQE		0.6	0.7
Feed-horn/cavity efficiency		0.70	
Field of view diameter (arcmin.)		2.6	
Max. spectral resolution (cm^{-1})		0.04	
Overall instrument transmission		0.15	
Signal modulation efficiency		0.5	
Observing efficiency		0.8	
Electrical filter efficiency		0.8	

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Background Power and NEP

		Photometer band (mm)			FTS band (mm)	
		250	350	500	200-300	300-670
Background power/detector	**pW**	**3.9**	**3.2**	**2.4**	**6.0**	**11**
Background-limited NEP	**W $Hz^{-1/2}$ x 10^{-17}**	**8.1**	**6.1**	**4.5**	**10**	**11**
Overall NEP (inc. detector)	**W $Hz^{-1/2}$ x 10^{-17}**	**10**	**7.3**	**5.4**	**12**	**14**

FTS figures are for current nominal bands – likely to be revised at this meeting

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1-σ; 1-sec. Sensitivity Estimates

NEFD (mJy Hz-1/2) for point source chopped observations

$$NEFDp_i := \frac{NEPtot_i \cdot 10^{-17} \cdot 10^{26} \cdot 1000}{\eta ch \cdot \eta tel \cdot 2^{0.5} \cdot Atel \cdot td_0 \cdot \Delta\nu_i \cdot t_0 \cdot \eta feed}$$

Factor of SQRT(2) from pixel-pixel chopping

NEFD (mJy Hz-1/2) for field mapping (jiggle mode)

$$NEFDf_i := \frac{NEPtot_i \cdot 10^{-17} \cdot 10^{26} \cdot 1000}{\eta ch \cdot \eta tel \cdot Atel \cdot td_0 \cdot \Delta\nu_i \cdot t_0 \cdot \eta feed}$$

No factor of SQRT(2) in the denominator as we are not pixel-pixel chopping

NEFD (mJy Hz-1/2) for scan map observations without chopping

$$NEFDs_i := \frac{NEPtot_i \cdot 10^{-17} \cdot 10^{26} \cdot 1000}{\eta tel \cdot Atel \cdot td_0 \cdot \Delta\nu_i \cdot t_0 \cdot \eta feed} \cdot 2^{0.5}$$

Factor of SQRT(2) assumes need for background subtraction (probably pessimistic as background can be estimated by averaging a number of scan points)

1-σ; 1 sec. limiting flux densities (mJy):

$$S\_1\sigma\_1s\_point_i := \frac{NEFDp_i}{2^{0.5}} \qquad S\_1\sigma\_1s\_field_i := \frac{NEFDf_i}{2^{0.5}} \qquad S\_1\sigma\_1s\_scan_i := \frac{NEFDs_i}{2^{0.5}}$$

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Jiggle-map mode

Deep mapping of one field for 1 hour in jiggle-map mode:

Loss in S/N for point source due to need to make a map:

S/N improvement through pixel co-addition

$$SN\_imp := 1.5$$

S/N reduction through decrease in integration time/point by factor of 16

$$SN\_red := 4$$

Overall reduction in S/N

$$factor := \frac{SN\_imp}{SN\_red} \qquad factor = 0.375$$

SPIRE

Sensitivity Estimates - Photometer

$\lambda_i =$	$Slim\_7\_pt\_5\_\sigma\_1hr_i =$	$\Delta S\_field\_1hr_i \cdot 5 =$
	Point source 7-point (mJy) 5 s 1 hr	**Field Map (mJy 5 s 1 hr)**
250	2.5	9.1
350	2.7	8.9
500	3.0	9.4

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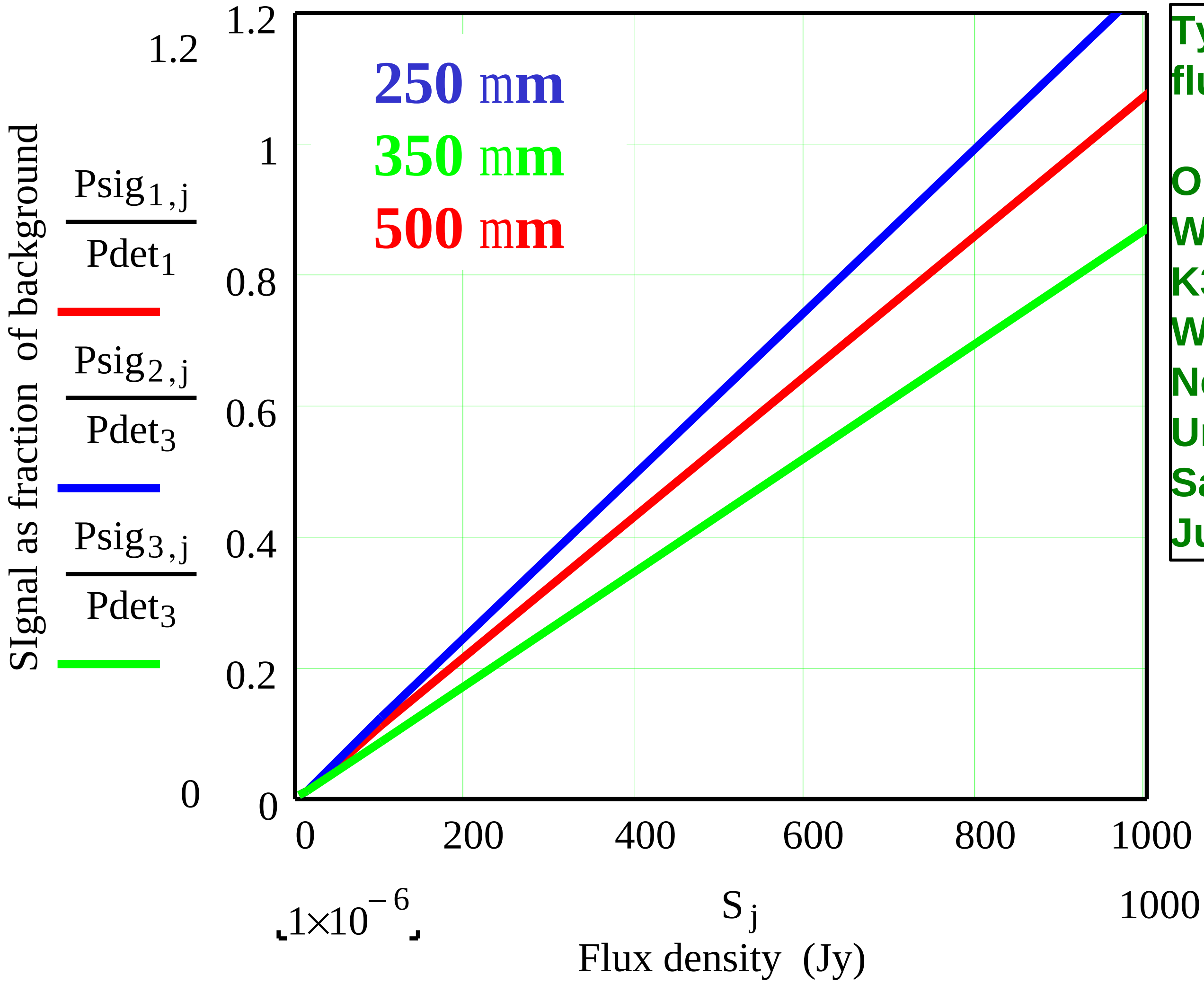
Sensitivity Estimates - Photometer

λ_i =	**Scan Map (mJy 5 s 1 hr)** $\Delta S\_scan\_5\_\sigma\_1hr_i$ =	**1 sq.deg. (15 mJy 5s) Days** $T\_1\_sq\_deg_i$ =	**100 sq.deg. 180 day survey (mJy 5s)** $\Delta S\_surv\_5\sigma_i$ =
250	7.2	1.9	15.2
350	7.1	1.8	15.0
500	7.4	2.0	15.7

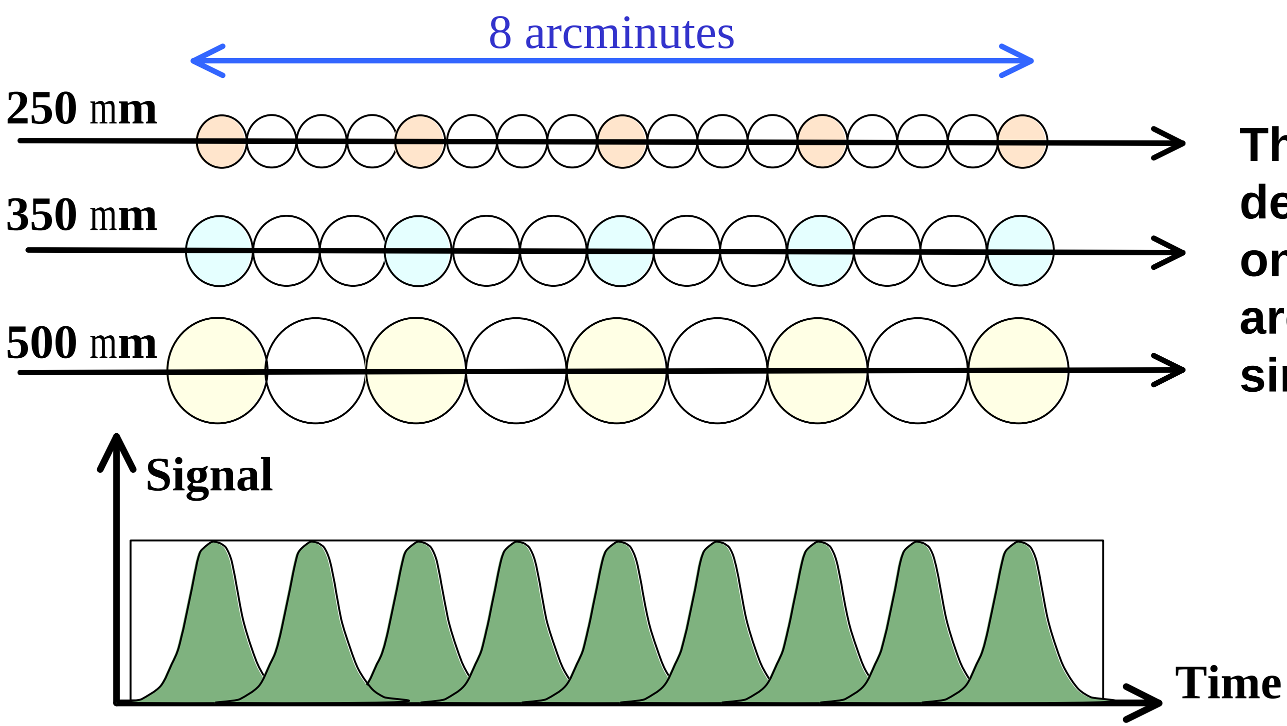
SPIRE Photometer: Signal a Fraction of Background



Typical 350-mm flux densities:

OMC1	1500
W3(OH)	680
K3-50	320
W75N	650
Neptune	100
Uranus	250
Saturn	7300
Jupiter	24000

SPIRE Point Source Photometry in Scanning Mode



Three lines of detectors overlap on the sky and are scanned simultaneously

- **For a given integration time:**
  - **Signal reduced by factor ~ dark area/total area** » **0.54**
  - **Observing speed loss µ (Signal reduction factor)^2** » **0.30**
- **Must allow for overhead due to telescope turn-around: factor of ~ 2**
- **Total loss in observing speed ~ 0.15 - roughly a factor of 7.**

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Scientific Optimisation – FTS Bands

- **Current:**
  - 200 - 300 μm (optimised for 250)
  - 300 - 670 μm (optimised for 350)
  - Assumed degradation by factor of 2 between 400 and 670 μm
  - Performance beyond 400 μm does not drive design
- **Proposed:**
  - 200 - 350 μm (optimised for 275)
  - 350 - 670 μm (optimised for 450)
- **Advantages:**
  - Better overall optimisation of performance across the full band
- **Disadvantages:**
  - Some compromise to short-wavelength performance
- **Constraints:**
  - No changes to any budgets or interfaces (minimal internal changes to BDAs and filters only)
  - No impact on schedule will be allowed
- **Status:**
  - Change should be made for CQM
  - Preliminary sensitivity modelling has been done
  - Decision needed soon

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Sensitivity Estimates – FTS

- **Problem designing LW horn for such broad band**
- **Proposed new bands:**

Array	Design λ_o (μm)	λ_L (μm)	λ_U (μm)	$\lambda/\Delta\lambda$
SW	275	200	355	1.79
LW	450	345	670	1.56

- **Broadening SW band and narrowing the LW band leads to a degradation in sensitivity for the SW band and an improvement for the LW band.**
- **Above values are under review – crossover wavelength may be reduced to ~ 320 μm**

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FTS Sensitivity Model

- Higher order modes are taken into account
- Broadening SW band and narrowing the LW band leads to a degradation in sensitivity for the SW band and an improvement for the LW band.
- Assumptions:
  - All higher order modes couple half as efficiently to the detector as the fundamental mode
  - Higher order modes introduce extra background but no additional signal
- Model is simplistic but provides a guide to the relative performance of the two options.

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Sensitivity Estimates – FTS

Old Bands

	Pdet absorbed (pW)	NEPs (W Hz-1/2 E-17)		Spectrophotometry (mJy 5-s ; 1-hr)		Spectroscopy (W m-2 5-s ; 1-hr)	
				Point source	Map	Point source	Map
	$Ptot_b =$	$NEPph_b =$	$NEPtot_b =$	$Slim_b =$	$\Delta S\_1hr_b =$	$Flim_b \cdot 10^{17} =$	$\Delta F\_1hr_b \cdot 10^{17} =$
LW	11.1	10.7	13.3	124	330	3.7	9.9
SW	6.1	10.1	12.5	117	312	3.5	9.4

New Bands

	Pdet absorbed (pW)	NEPs (W Hz-1/2 E-17)		Spectrophotometry (mJy 5-s ; 1-hr)		Spectroscopy (W m-2 5-s ; 1-hr)	
				Point source	Map	Point source	Map
	$Ptot_b =$	$NEPph_b =$	$NEPtot_b =$	$Slim_b =$	$\Delta S\_1hr_b =$	$Flim_b \cdot 10^{17} =$	$\Delta F\_1hr_b \cdot 10^{17} =$
LW	7.4	8.2	10.2	95	254	2.9	7.6
SW	9.0	12.0	14.9	139	371	4.2	11.1

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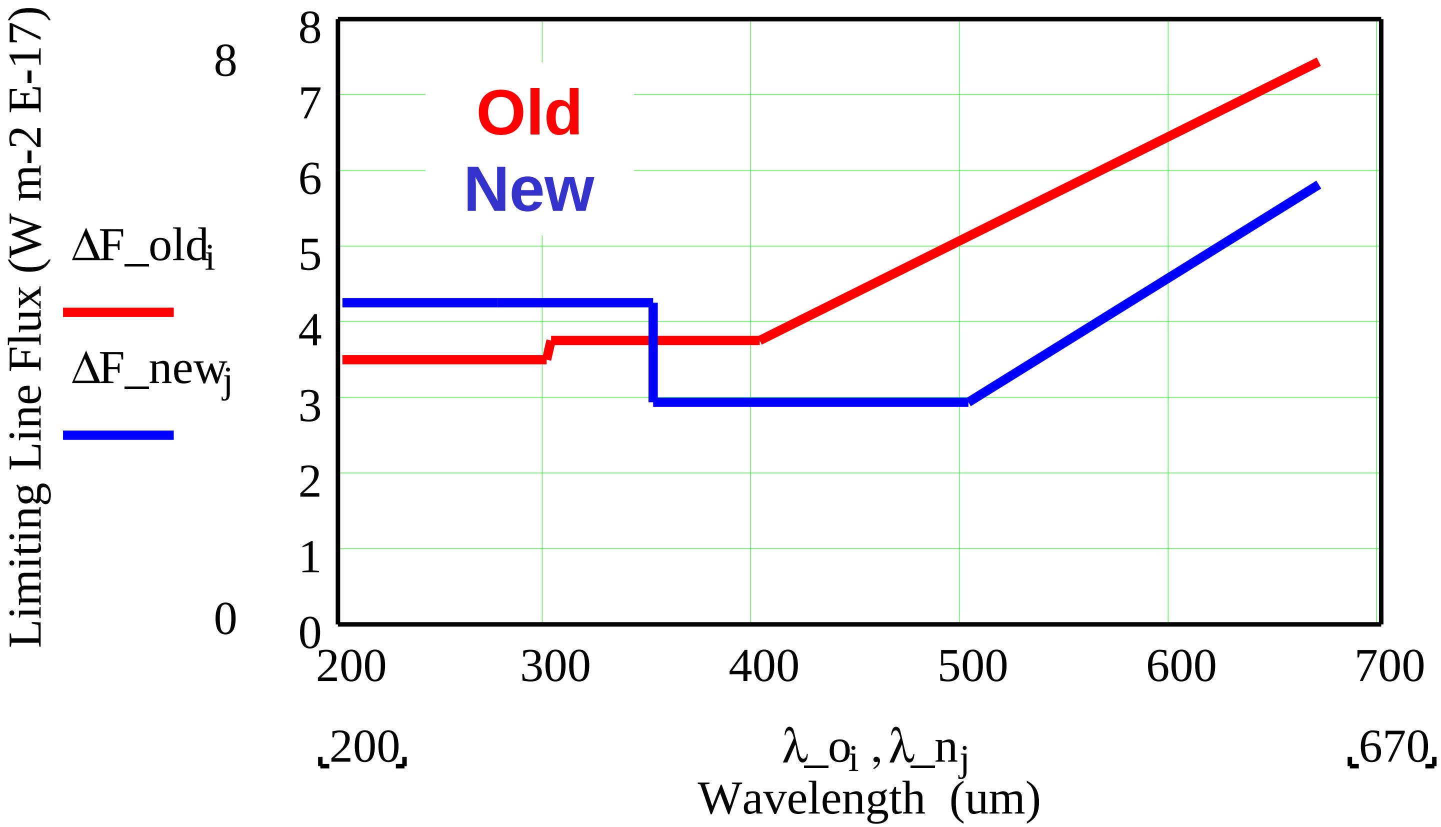
Indicative FTS Sensitivity Comparison New Bands vs. Old



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Sensitivity Estimates – FTS

- New bands give a more even optimisation of the FTS performance over its whole range
- FTS performance is
  - generally improved for low-resolution spectrophotometry
  - improved for line spectroscopy or spectral surveys over 330 - 670 μm
  - degraded for line spectroscopy or spectral surveys over 200 - 300 μm
  - slightly degraded for the 300-350 μm range
- Big gain for the LW band, especially at longer wavelengths. LW band will now be well-optimised up to around 550 μm at least rather than only 400 μm as before.
- Loss in sensitivity for the SW band (20% in sensitivity or 40% in observing speed) is inevitable due to the additional photon noise.

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Sensitivity Estimates – FTS

- **Reoptimisation is compatible with use of the FTS as a survey spectrometer and solves the problem of the very broad 300-670 μm band.**
- **Further study/analysis needed to model sensitivity and beamwidth vs. wavelength more accurately**
- **Recommendation:**
  - **Modified bands (or something close) should be adopted as the new baseline**
  - **Some further study needed to fix the exact crossover wavelength**

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Uncertain Background Power

Uncertainties:

1. ϵ, T of telescope mirrors and wavelength dependence
   - Spec. is total throughput > 0.97 so worst case should be $\epsilon = 3\%$
   - Sensitivity model assumes 4% to allow for some stray light component
   - Telescope temperature likely to be 60 – 90 K
2. Stray light properties of the Herschel system have not been fully modelled. This modelling is very difficult in any case, and the results may not be completely reliable.
3. Overall optical efficiency of SPIRE

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Background Power Estimation

Assumptions:

- NTD bolometer model: ideal thermal behaviour
- Electronics chain contributes a fixed noise level
- Optimum design impedance for bolometer is ~ 5 MW
- Bias can be adjusted to the optimum at the actual background

- Nominal bolometer design parameters:

Band	?o (mm)	Qexp (pW)	GS0 pW K^{-1}	t (ms)	3-dB Freq. (Hz)
P/SW	250	4.0	62	11.4	14
P/MW	350	3.2	51	13.9	11
P/LW	500	2.4	40	17.8	8.9
S/SW	250	9.0	144	4.9	33
S/LW	350	7.4	123	5.7	28

R_s = 180 W T_g = 41.8 K   To = 300 mK e_n = 10 nV $Hz^{-1/2}$

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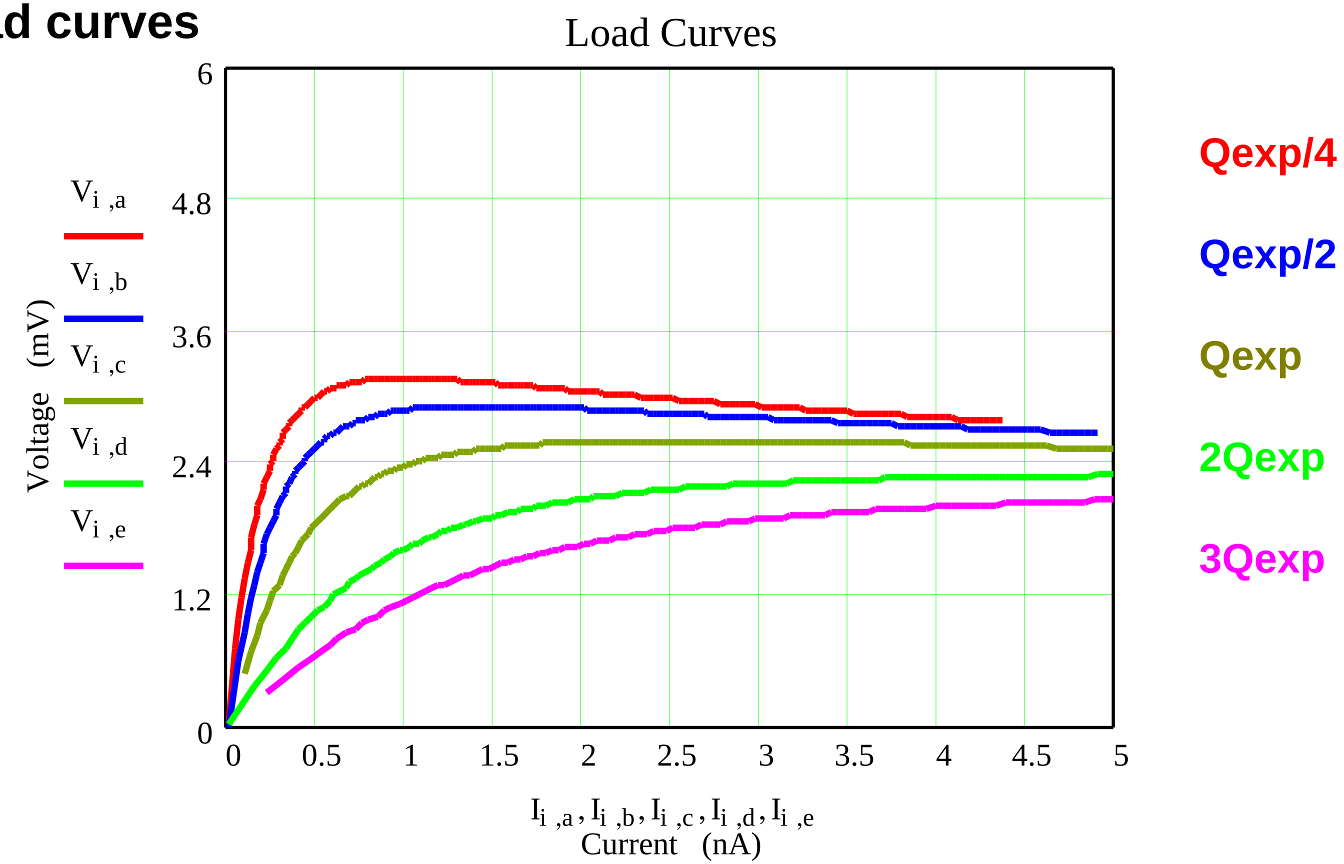
Effects of Background Power on the Bolometers

Example: 350 mm Q_{exp} = 3.2 pW Q_{des} = 1.6 pW

Load curves



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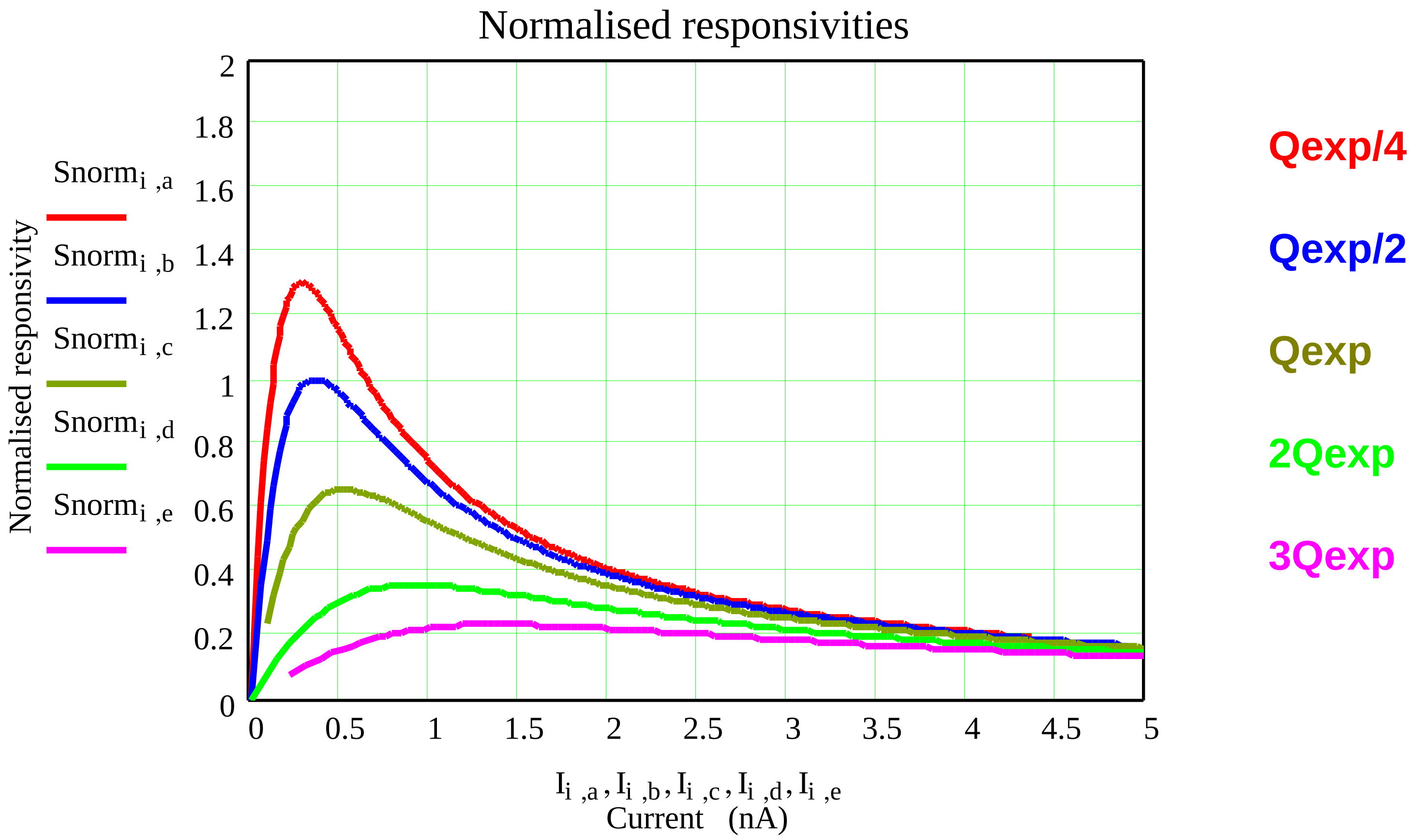
Effects of Background Power on the Bolometers

Responsivity vs. bias



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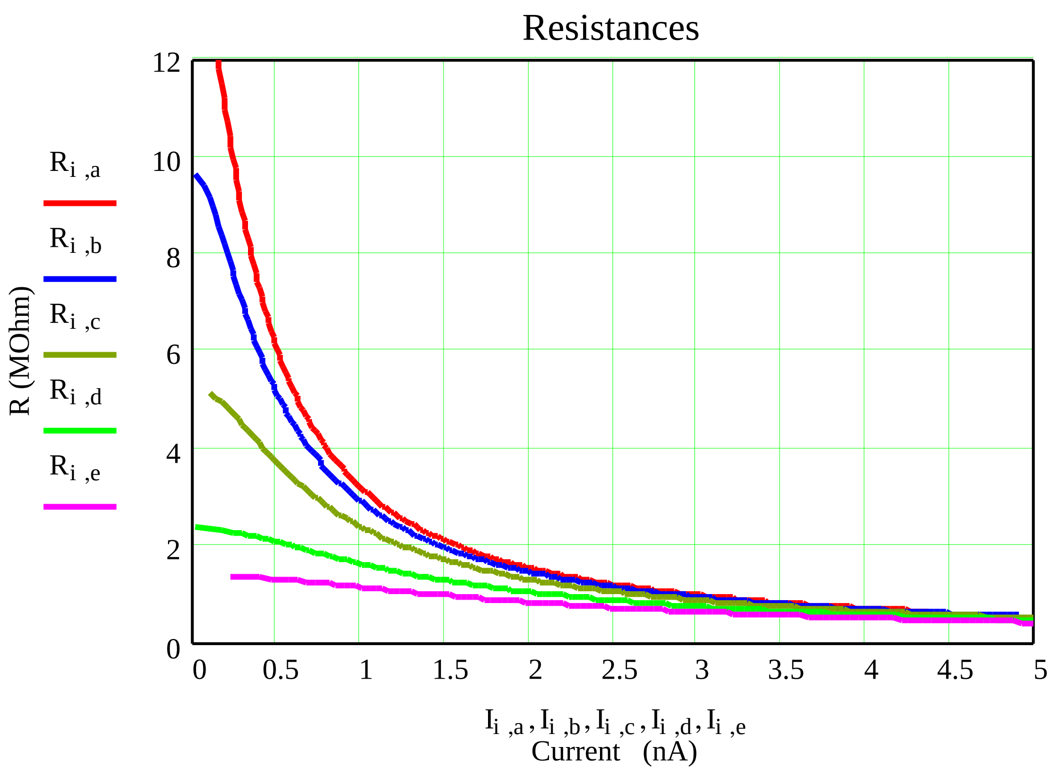
Effects of Background Power on the Bolometers

Resistance vs bias



Qexp/4

Qexp/2

Qexp

2Qexp

3Qexp

Resistance at the optimum bias point for Q = Qdes is about 6 MW.

It rises to around 8 MW if Q = Qdes/2

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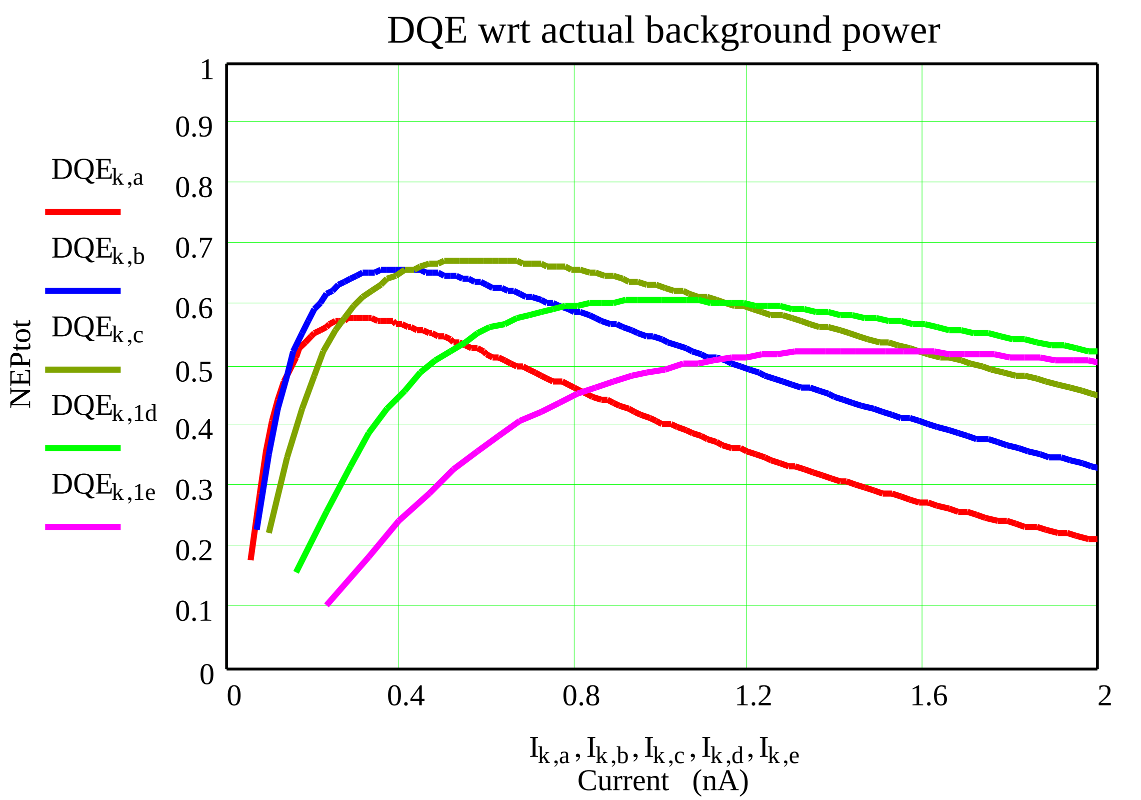
Effects of Background Power on the Bolometers

DQE (at actual background power) vs. actual background power



Qexp/4

Qexp/2

Qexp

2Qexp

3Qexp

DQE is insensitive to the bias current as long as it's not too small

DQE is relatively insensitive to the background as long as the bias is adjusted to optimise at the actual background

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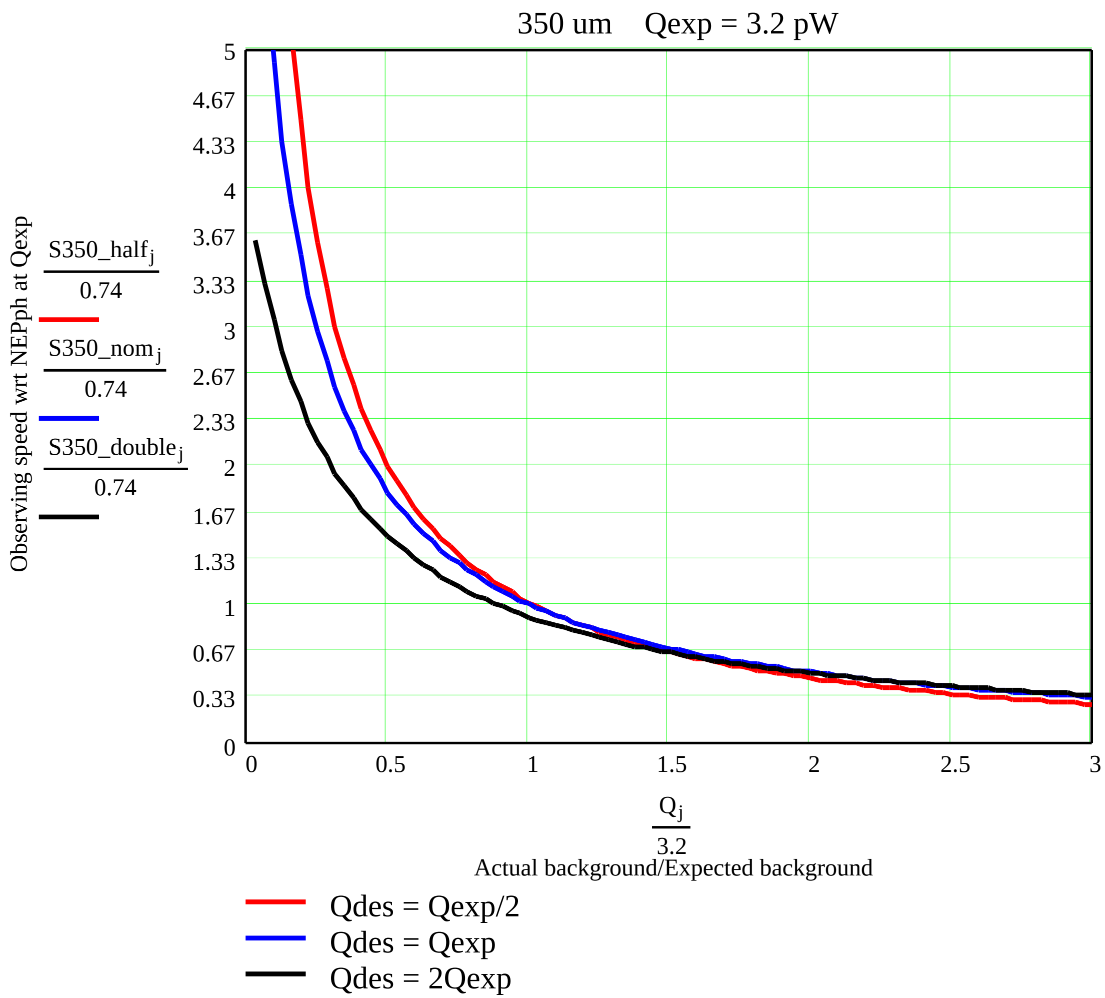
Effects of Background Power on the Bolometers

Observing speed vs. actual background power (350 μm)



Qdes (pW)	GS0 (pW K-1)
Qexp/2	26
Qexp	51
2Qexp	102

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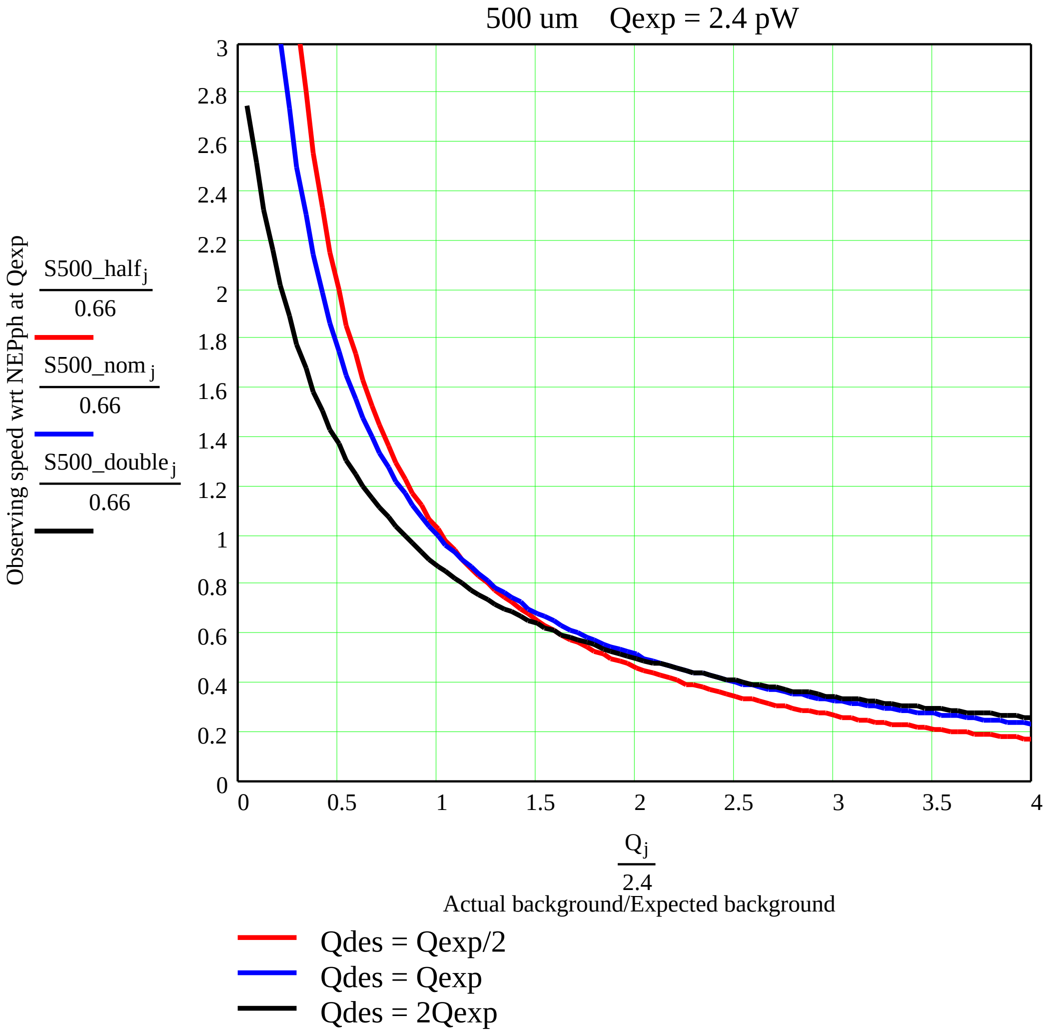
Effects of Background Power on the Bolometers

Observing speed vs. actual background power (500 μm)



Qdes (pW)	GS0 (pW K-1)
Qexp/2	20
Qexp	40
2Qexp	80

Background Power: Conclusions

Conclusions

1. **Sensitivity improves or degrades smoothly with background power.**

2. **If the background is excessively high we lose sensitivity due to additional photon noise, with the bolometer design (GSo) making very little difference.**

   If the background is lower than expected, we will gain accordingly.

3. **The potential gain in performance is higher if we design for a lower background than the expected one, but not dramatically so.**

4. **Designing for low background involves compromising speed of response somewhat in order to take advantage of the potential sensitivity gain.**

   Preliminary recommendation: design for $Q_{des} = Q_{exp}$ at 4% effective emissivity

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Background Power: Conclusions

- **Sensitivity improves or degrades smoothly with background power.**
- **If the background is excessively high we lose sensitivity due to additional photon noise, with the bolometer design (GSo) making very little difference.**
- **If the background is lower than expected, we will gain accordingly.**
- **The potential gain in performance is higher if we design for a <u>lower</u> background than the expected one, but not dramatically so.**
- **Designing for low background involves compromising speed of response somewhat in order to take advantage of the potential sensitivity gain.**
- **Preliminary recommendation: design for $Q_{des} = Q_{exp}$ at 4% effective emissivity.**

SPIRE

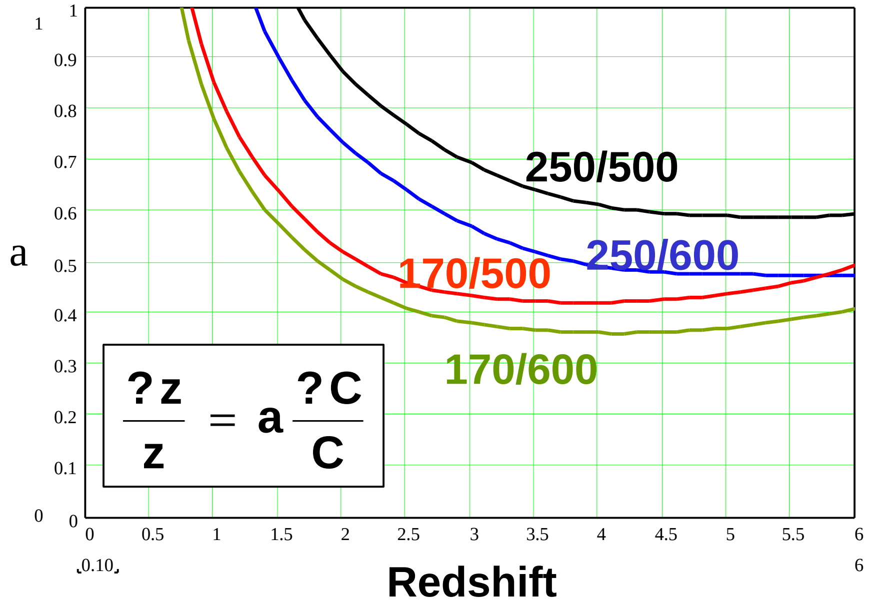
Photometer Bands

- Current	:	250	350	500 mm
- Proposed	:	250	350	~600 mm

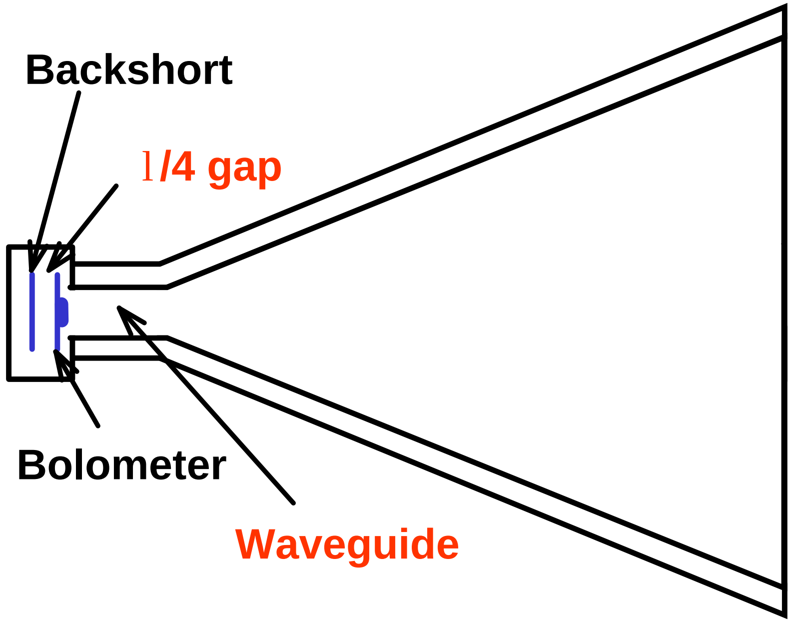
- **Possible advantages:**
  - Improved ability to identify high-z galaxies from SPIRE colours
  - Ability to detect S-Z increment
- **Disadvantages:**
  - Larger beamwidth (43” at 600 mm vs. 36” at 500 mm)
  - Lower sensitivity and some loss of field due to vignetting
    Þ Reduced mapping speed for large surveys
- **Constraints:**
  - No changes to any budgets or interfaces (minimal internal changes to BDAs and filters only)
  - No change for CQM
  - No impact on schedule will be allowed
- **Status/Plans:**
  - Study needed of scientific and technical trade-offs and impact of making the change

Photometer LW Band Options

Redshift Discrimination (Starburst-type SED)



Internal design change to waveguide diameter and backshort gap



SPIRE Instrument Development Plan

K.J. King

RAL

Documentation

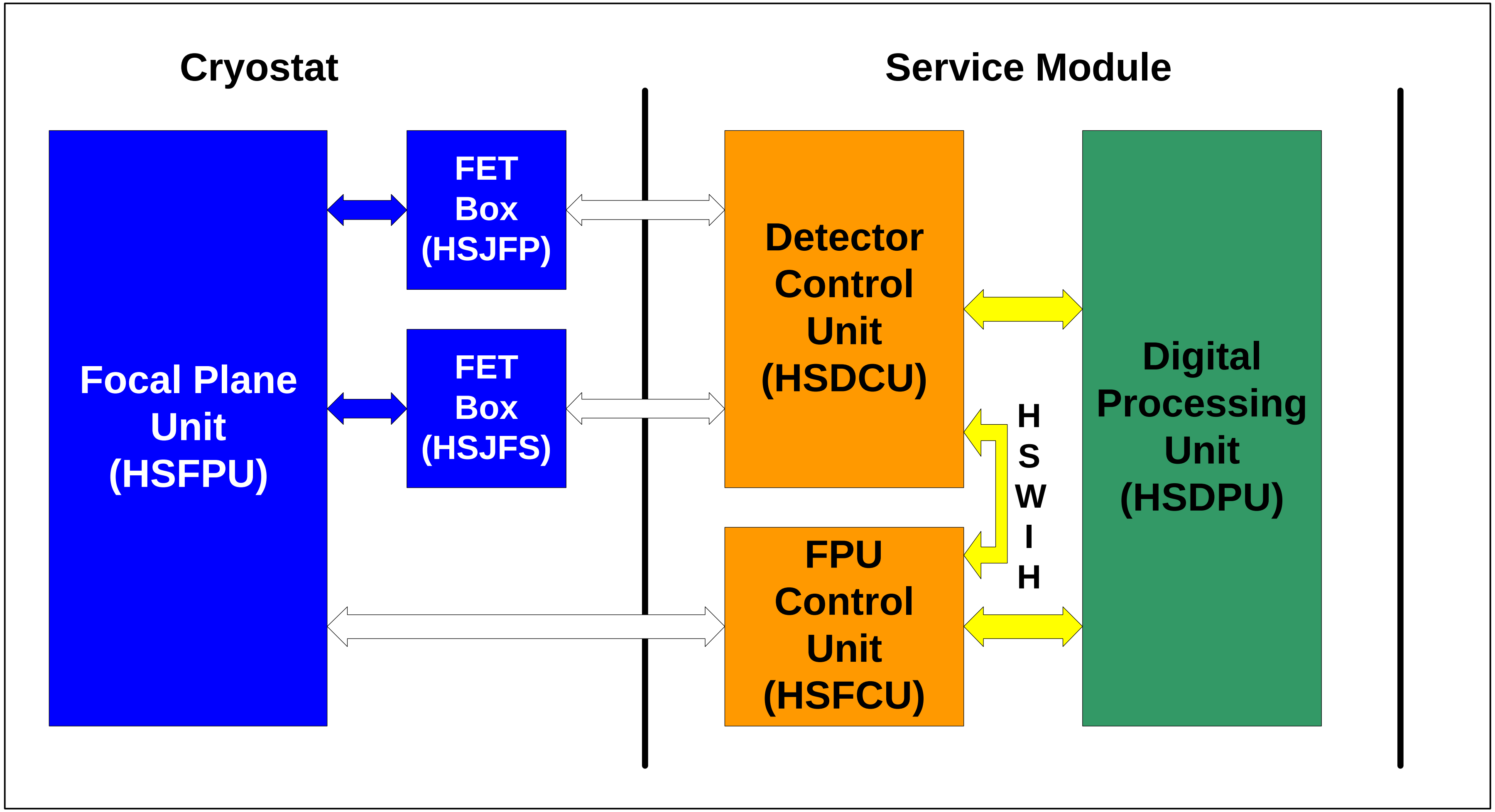
- **The Instrument Development Plan gives an overview of development activities:**
  - **Instrument Models**
  - **Deliverable Subsystems**
  - **Qualification activities**
  - **AIV**
  - **Organisation**
  - **Schedule**
  - **Risk Assessment**
- **It is supplemented by additional documents:**

Additional Development Documentation

- **Product Tree**
- **Work Breakdown Structure**
- **Qualification Requirements Document**
- **AIV Documentation**
- **Milestone List**
- **Schedule**

- **a development plan for each subsystem, including simulators, test equipment and facilities**

SPIRE Instrument Units



Instrument Models

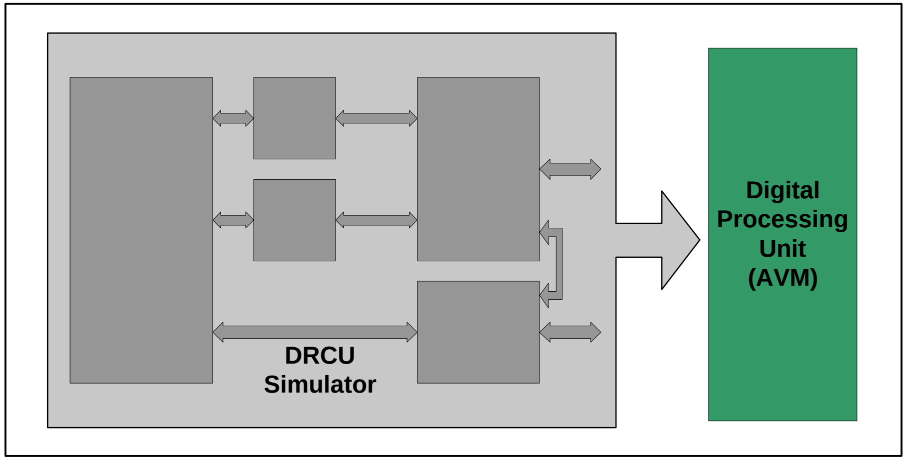
- **Avionics Model (AVM)**
- **Structural/Thermal Model (STM)**
  - **FPU and JFET boxes only**
- **Cryogenic Qualification Model (CQM)**
- **Electronics Qualification Model (EQM)**
  - **Warm electronics (DPU, DRCU, WIH) only**
- **Proto-Flight Model (PFM)**
- **Flight Spare (FS)**

Currently the purpose, tests and schedule for these models are ill-defined. A joint ESA/Alcatel/Instrument meeting is planned for June 18-20

Avionics Model (AVM)

- **Purpose**
  - verification of electrical interfaces to the S/C
  - verification of software (protocol) interfaces to the S/C
  - verification of operational procedures
  - verification of autonomous operation
  - the last 2 require ability to modify the behaviour of the 'instrument' - use a simulator

- **Configuration (DPU)**
  - no redundancy
  - commercial parts
  - form and fit identical to PFM

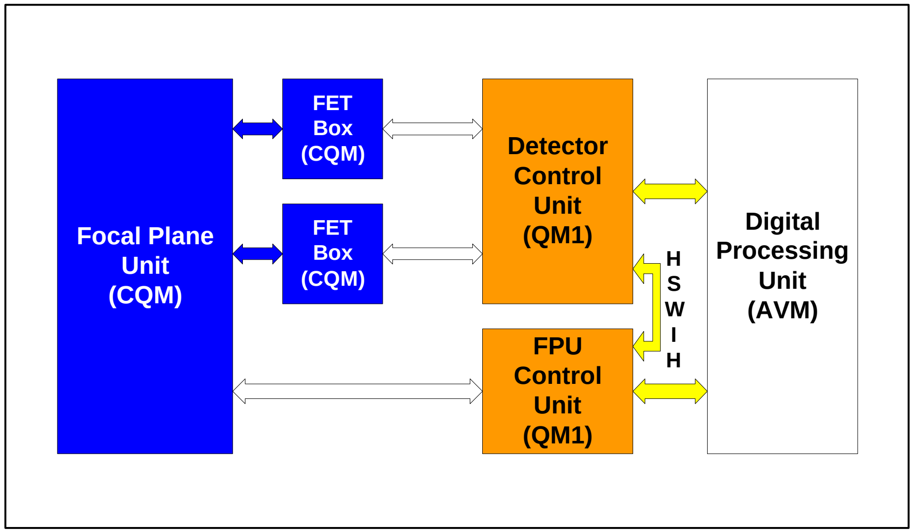


Structural/Thermal Model (STM)

- **Purpose**
  - to gain confidence in the ability of the structure to meet the structural requirements - by comparison of warm vibration with FE analysis
  - cold vibration qualification of the Structure (and cooler)
  - to verify the alignment procedure
  - to validate thermal model (except 300mK)
- **Configuration**
  - CQM Structure, mirrors, cooler (part time)
  - Optical/mass(/thermal) dummies of the BSM and FTS Mechanisms
  - Mass(/thermal) models of other major subsystems

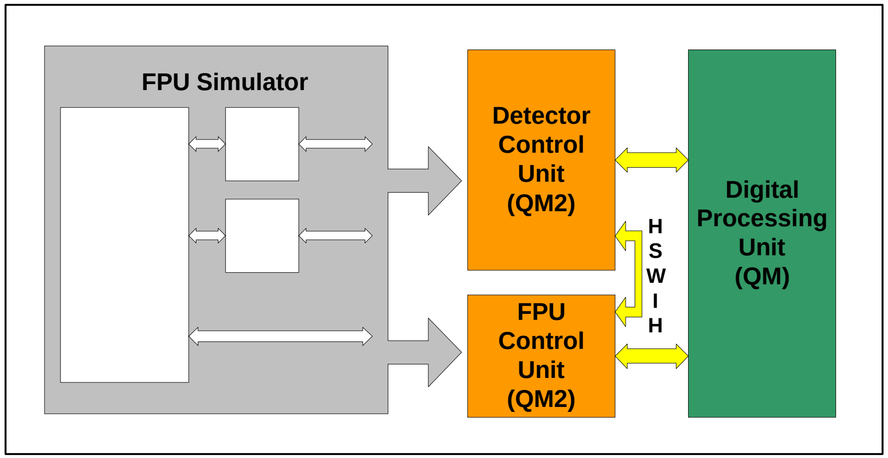
Cryogenic Qualification Model (CQM)

- Purpose
  - to verify the instrument functionality
  - to check instrument scientific performance
  - to verify the compatibility with other instruments in the payload
  - to start checking instrument operating modes and procedures
- Configuration
  - subsystems not necessarily flight-like
  - not all redundancy
  - not all pixels



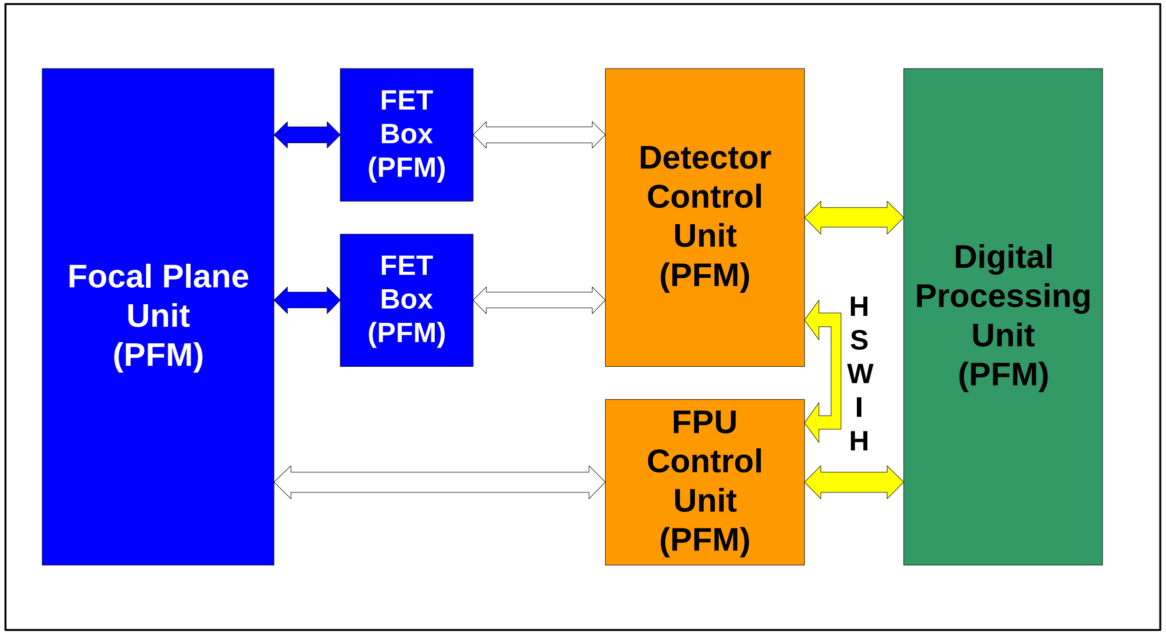
Electronics Qualification Model (EQM)

- Purpose
  - to qualify the instrument warm electronics units
    - Thermal Range testing, EMC (conductive)
  - to perform the initial PFM testing
- Configuration
  - DPU
    - form and fit compatible with PFM
  - DRCU & WIH
    - flight-equivalent components
    - form and fit compatible with PFM



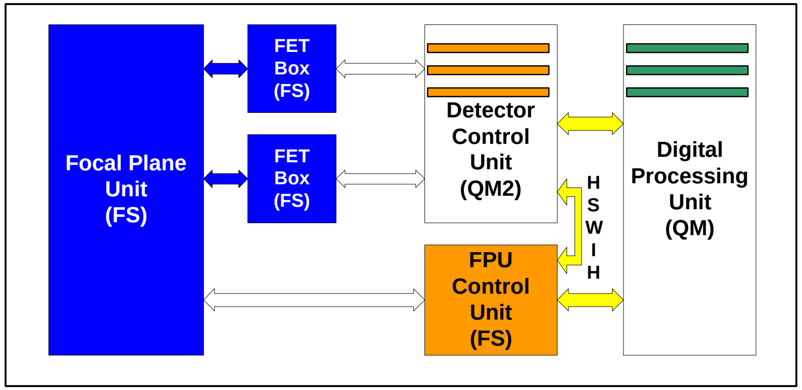
Proto-Flight Model

- **Purpose**
  - to provide excellent science
- **Configuration**
  - totally flight-like

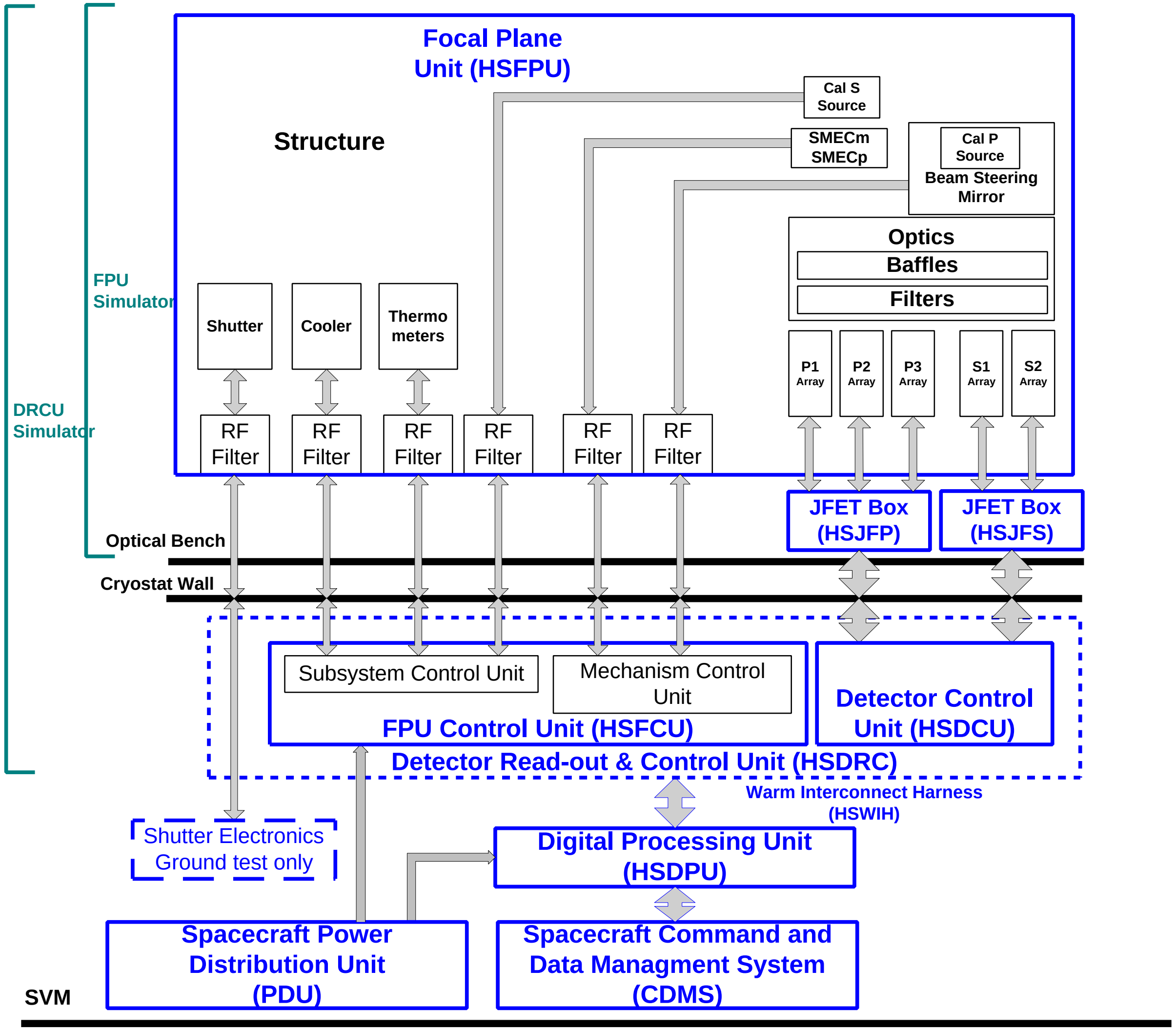


Flight Spare Model

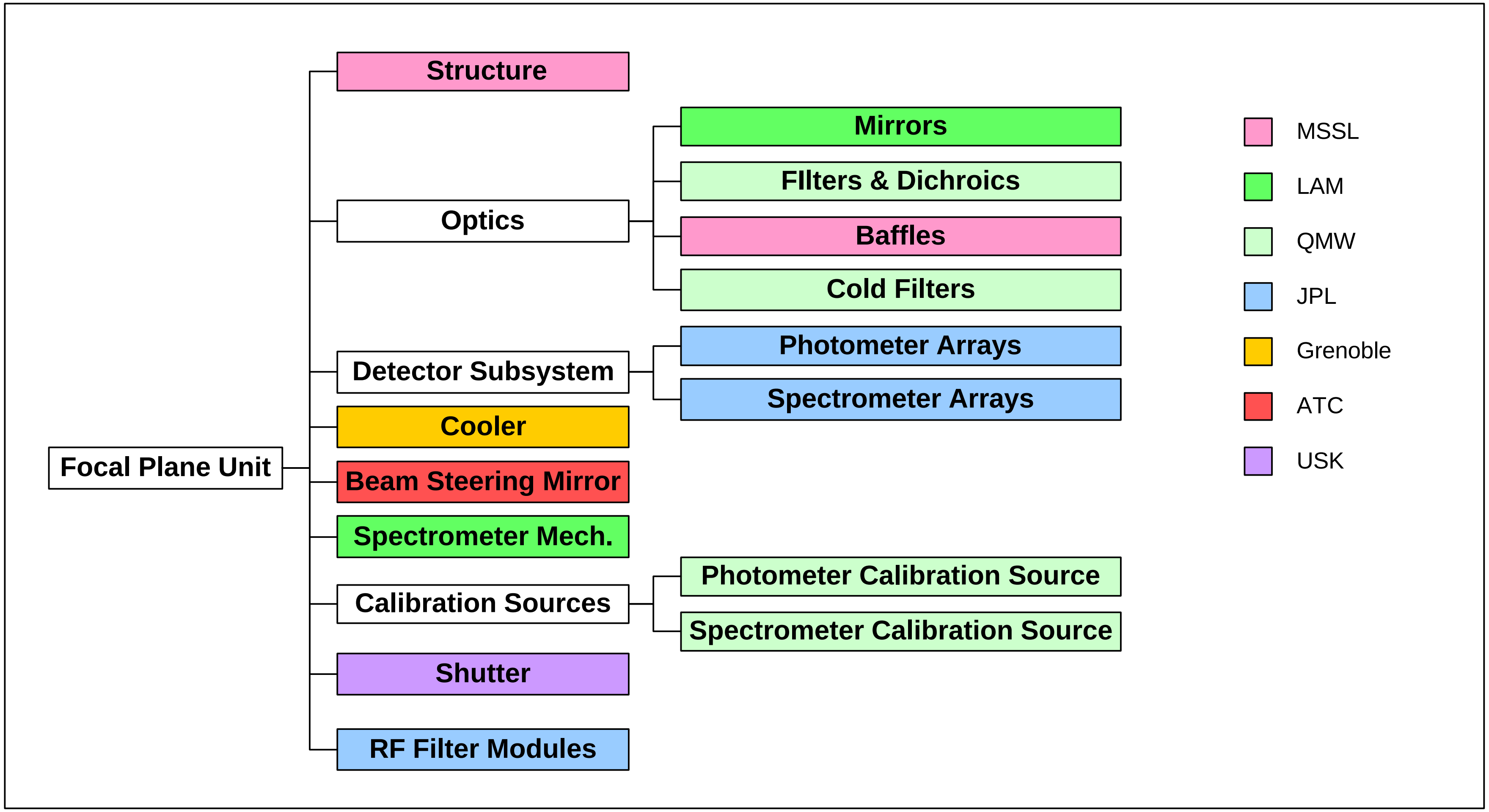
- **Purpose**
  - to replace PFM units in the event of failure
- **Configuration**
  - FPU and JFET Boxes
    - fully built and tested spare unit
    - may contain refurbished CQM subsystems
  - DRCU - spare cards, units TBC
  - WIH - fully built and tested spare unit
  - DPU - spare cards only
    - shared with other instruments



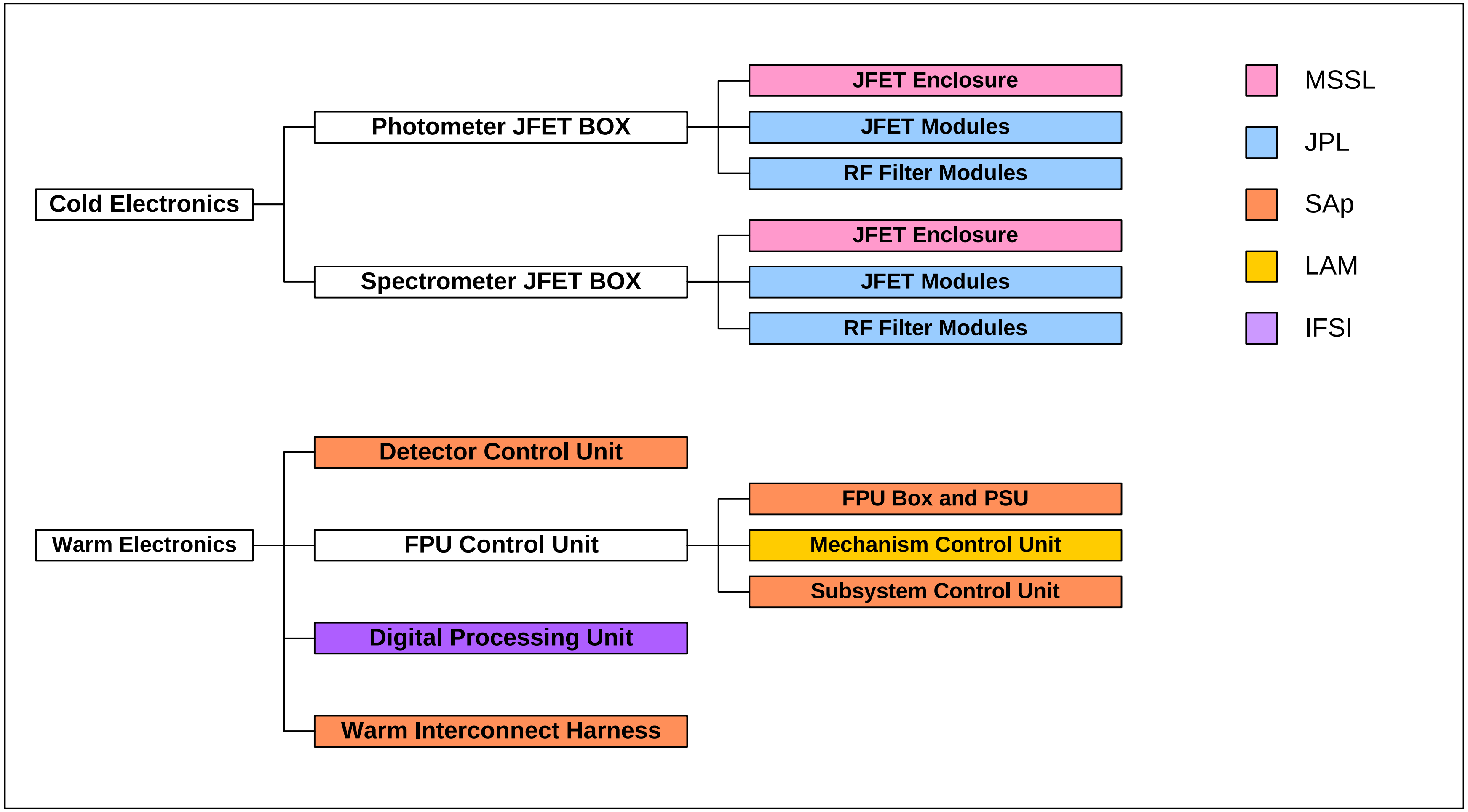
Instrument Block Diagram



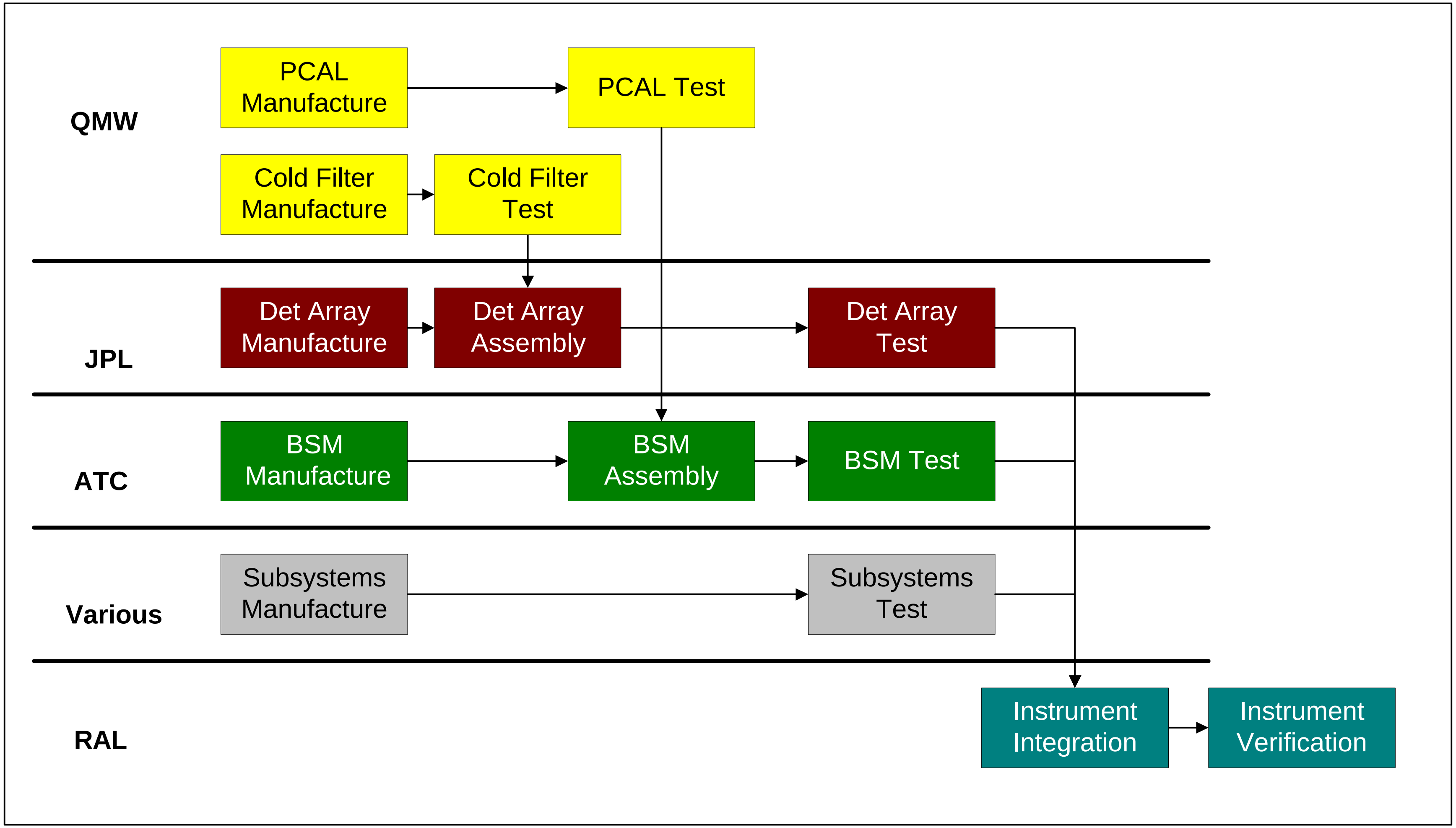
Focal Plane Unit Breakdown



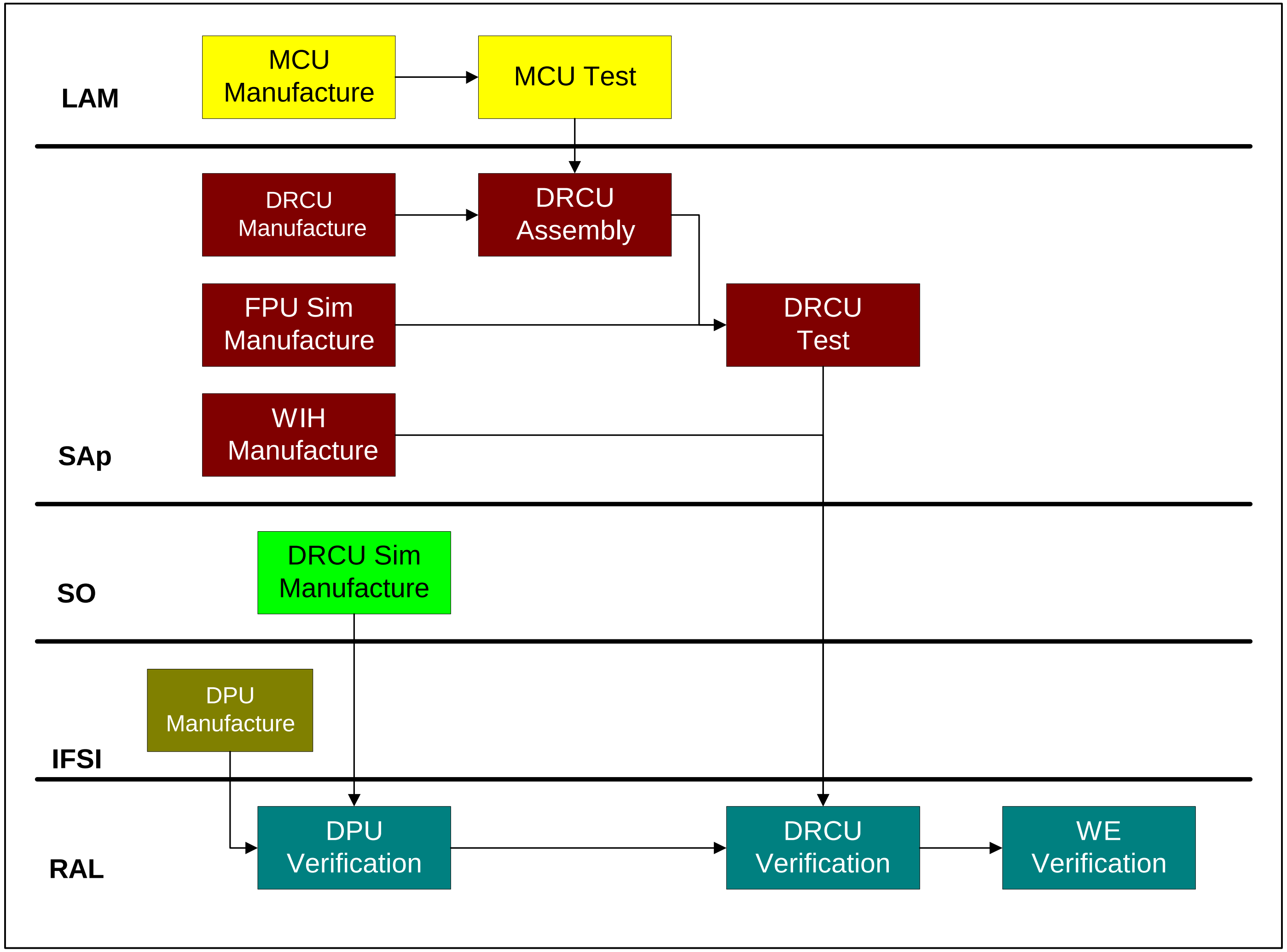
Electronics Breakdown



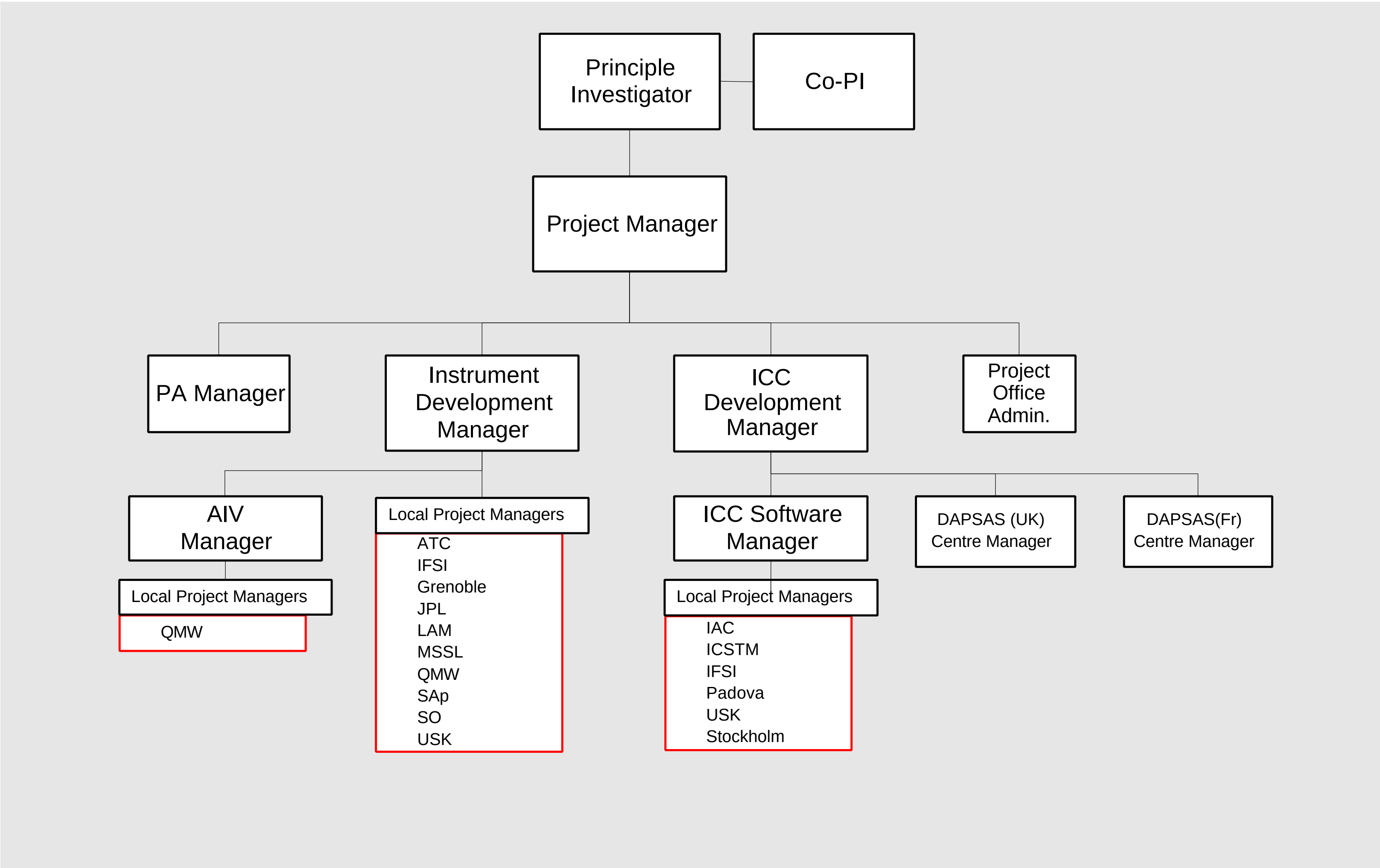
Focal Plane Unit AIV



Warm Electronics AIV



Management Organisation



Subsystems → System Design Coordination Team ← ESA/Prime Contractor

System Design Coordination Team

Matt Griffin	PI
Ken King	Project Manager
Colin Cunningham	FPU Systems Engineer
Bruce Swinyard	Instrument Scientist
John Delderfield	Instrument Systems Engineer
Doug Griffin	Assistant Systems Engineer

Optical System Team

Kjetil Dohlen	FPU Optical Eng.
Martin Caldwell	Diffraction Analyst
Tony Richards	Stray Light Analyst

Detectors System Team

Jamie Bock	Det. Systems Scientist
Viktor Hristov	Electronics Engineer
Dustin Crumb	Mechanical Engineer
Hien Nguyen	Array Test Engineer

Structural/Thermal System Team

Berend Winter	FPU Structural Eng.
Sam Heys	FPU Thermal Eng.
Lionel Duband	^{3}He Cooler Eng.
Terry Cafferty	Det. Thermal Eng.

Electronics System Team

Riccardo Cerulli	DPU Engineer
Christophe Cara	DRCU Engineer
Didier Ferand	MCU Engineer
Frederic Pinsard	DCU Engineer

Software/Ground Segment System Team

Anna Di Giorgio	OBS Engineer
Sunil Sidher	Operations Scientist
Seb Oliver	ICC Scientist

Development Management

- **Combination of Management Team and System Team forms the 'Project Team'**
  - **This meets regularly (nominally every 2 weeks) to discuss project progress and to plan future activities (reviews, meetings etc)**
  - **Minutes are circulated to the consortium**
- **Project management Teleconferences take place weekly to monitor progress, clarify Project Team decisions etc.**
- **Design meetings occur as and when felt necessary.**

Qualification

- Qualification of the instrument will be carried out both at subsystem and instrument levels, as defined in the Qualification Requirements:
  - Instrument-level testing is included in the AIV Plan
  - The testing carried out on the STM/CQM instrument will provide the information needed for the subsystem tests to be carried out
  - Individual subsystems will carry out their own qualification tests, usually on additional qualification models of the subsystem.

Major Risks (Technical)

Risk	Impact	Preventative Action
Structure or other subsystem failure during cold vibration	Delay to programme while subsystem is modified	Use of STM allows early testing of structure and determination of vibration loads on other subsystems. Vibration qualification of subsystems can be carried out in parallel to CQM testing in preparation for PFM
Thermal Design of instrument does not meet requirements	Delay to programme while thermal design is modified	STM testing will provide early indication of possible problems. These can be addressed in parallel to CQM testing, provided that they do not prevent operation of the CQM
Optical alignment does not meet requirements	Delay to programme while optical design is modified	Optical design minimises alignment requirements. STM testing will provide early indication of possible problems. These can be addressed in parallel to CQM testing, provided that they do not prevent operation of the CQM
Need for thermal control of detector temperature	Additional sensor and OBS control algorithms required	Baseline is to include the necessary hardware. OBS will be updated if needed.

Major Risks (Programme)

Risk	Impact	Preventative Action
Late delivery of subsystem	Possible delay to instrument delivery	Regular monitoring of milestone status and margin will identify problems early. This will allow corrective action to be taken.
Late delivery of shutter, which has started development later than other subsystems	Delay to programme or inability to test detectors at the satellite level.	Check possible options for testing detectors in high background environment
Delay to provision of Cold Vibration facility by ESA	Cold STM Vibration testing will be delayed	Cold vibration qualification of subsystems (apart from structure) has been removed from CQM delivery programme and can be carried out later, provided it is done in time for PFM manufacture. Structure testing remains a problem
Late definition of S/C interfaces	Delay in completing Detailed Design Reviews and starting manufacture	An approach to quick resolution of these items needs to be put in place immediately. Alcatel-Instrument meetings are a good start.
Resources not sufficient to handle Alcatel/ESA joint management scenario	Inability to manage / monitor instrument programme adequately	Minimise extra work associated with this; No extra reporting requirements Minimise meetings, using telconferences in preference.

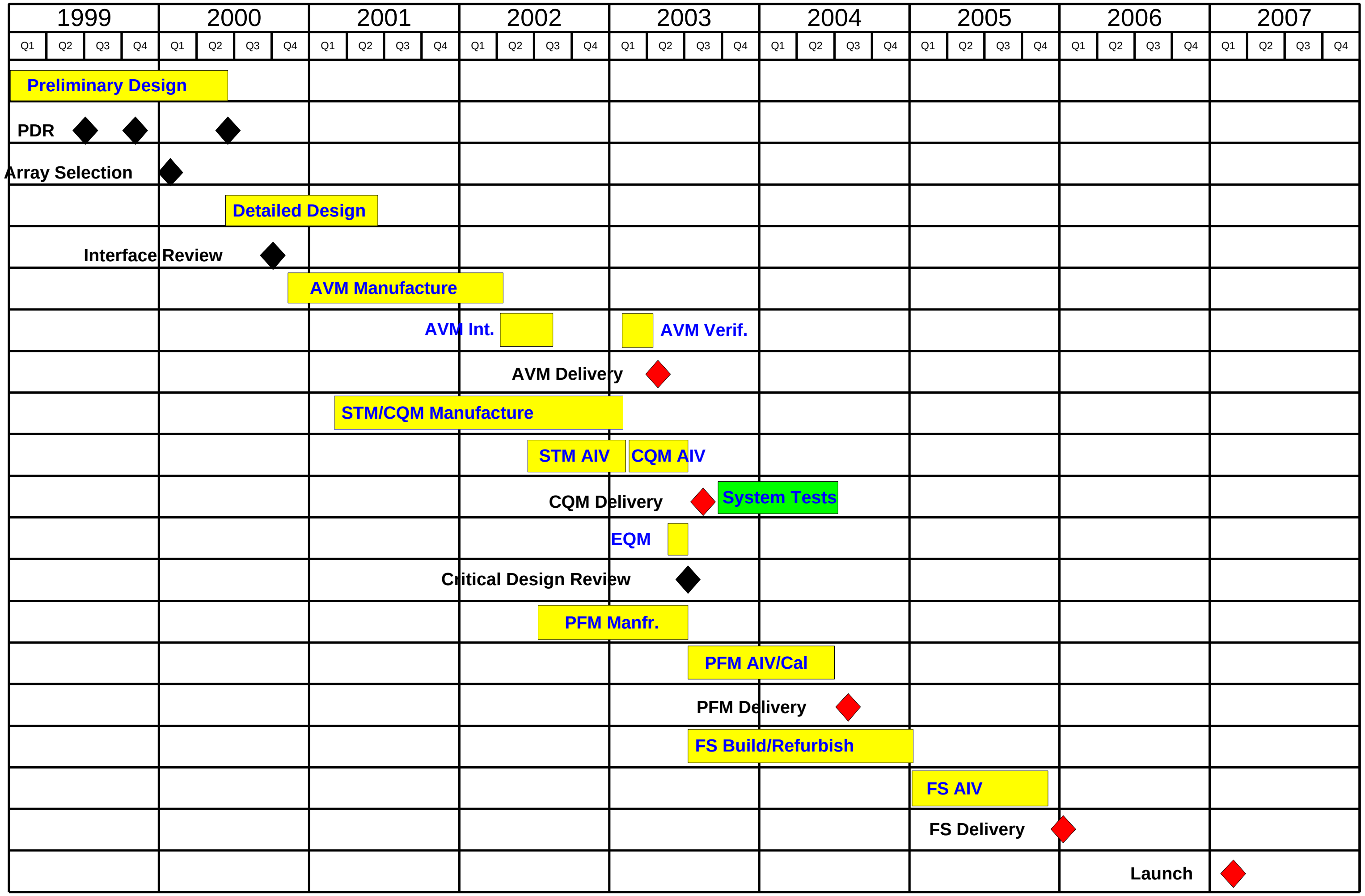
Schedule Definition

- Subsystem and AIV schedules were produced for the PDR.
- They have been consolidated based on a set of major milestone dates, identified as the dates for all deliveries between institutes, plus major reviews.
- The (time) critical lines have been identified and need dates for other subsystems adjusted to meet this schedule
  - this leads to a planned delivery date for each model with no margin (on critical lines)
- The resultant schedule is defined in the Major Milestone List, which gives the agreed need date, the planned delivery date and the current margin for each deliverable item
- The Major Milestone List also identifies an additional overall margin that gives a realistic delivery date for each model.
    - the method of handling of this margin is to be agreed with the Prime contractor

Schedule Management

- **Monthly reporting will be against the agreed Major Milestone List**
  - **problems should be initially identified in the weekly management teleconferences**
  - **changes in the margin will be discussed and agreed between the Project and Local PMs**
- **Items on the critical path will be monitored more closely:**
  - **a more complete set of internal milestones will be defined**
  - **these will be reported on and monitored at regular progress meetings**

SPIRE Overall Schedule



SPIRE Schedule Summary

- **AVM**
  - **could be delivered on time, but**
    - **requires QM DPU to arrive in time to carry out CQM testing**
    - **AVM would contain no feedback from use with a real instrument - s/w update could remedy this**
  - **Delivery** 1 Jun 03 **(2 months margin)**
- **CQM**
  - **Schedule driven by manufacture of the Structure and need to carry out STM tests (vibration, thermal balance, alignment) to mitigate risk**
  - **critical item is the Structure with ~ 4 days margin**
  - **all other items have margin > 1 month**
  - **Delivery** 1st Oct 03 **(2.5 months margin)**

SPIRE Schedule Summary (cont.)

- **PFM**
  - AIV Starts immediately after delivery of CQM - if CQM testing extended then this will be in parallel to PFM integration
  - problem transferring information from CQM tests to PFM
  - All subsystems have >1 month margin (BDAs, TBC) except DRCU now has a problem delivering on time
  - Delivery 1st Sep 04 (2.5 months margin)
- **FS**
  - Structure (and Cooler possibly) to be refurbished from CQM - current estimated time needed is ~7 months.
  - Assumed 9 months testing of CQM - return of CQM 1st June 04
  - Available 1st Jan 06 (1 month margin), fully tested and calibrated (if we have the resources).
  - Problems
    - FS digital electronics only available as boards and these are shared between instruments

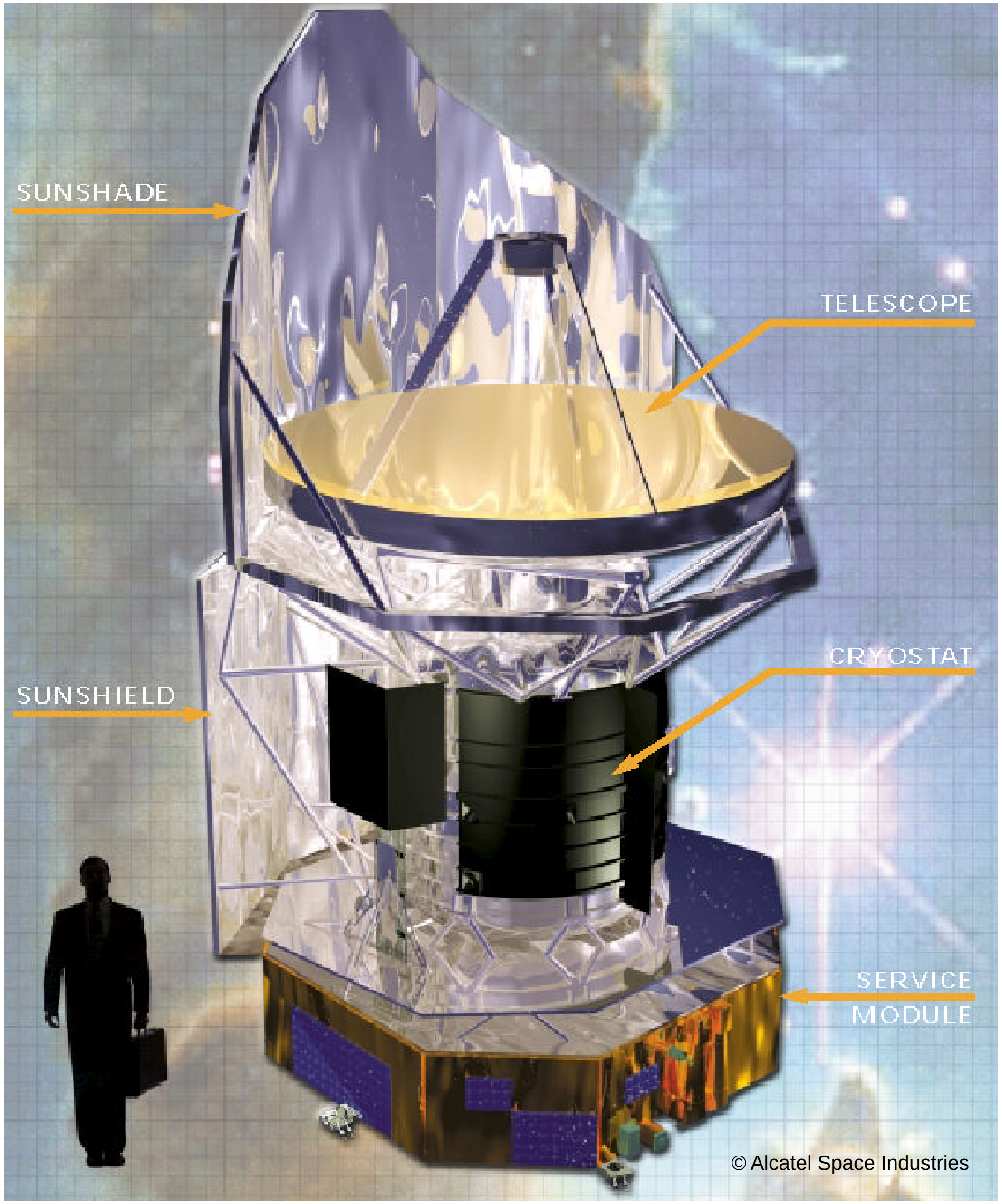
SPIRE SYSTEM

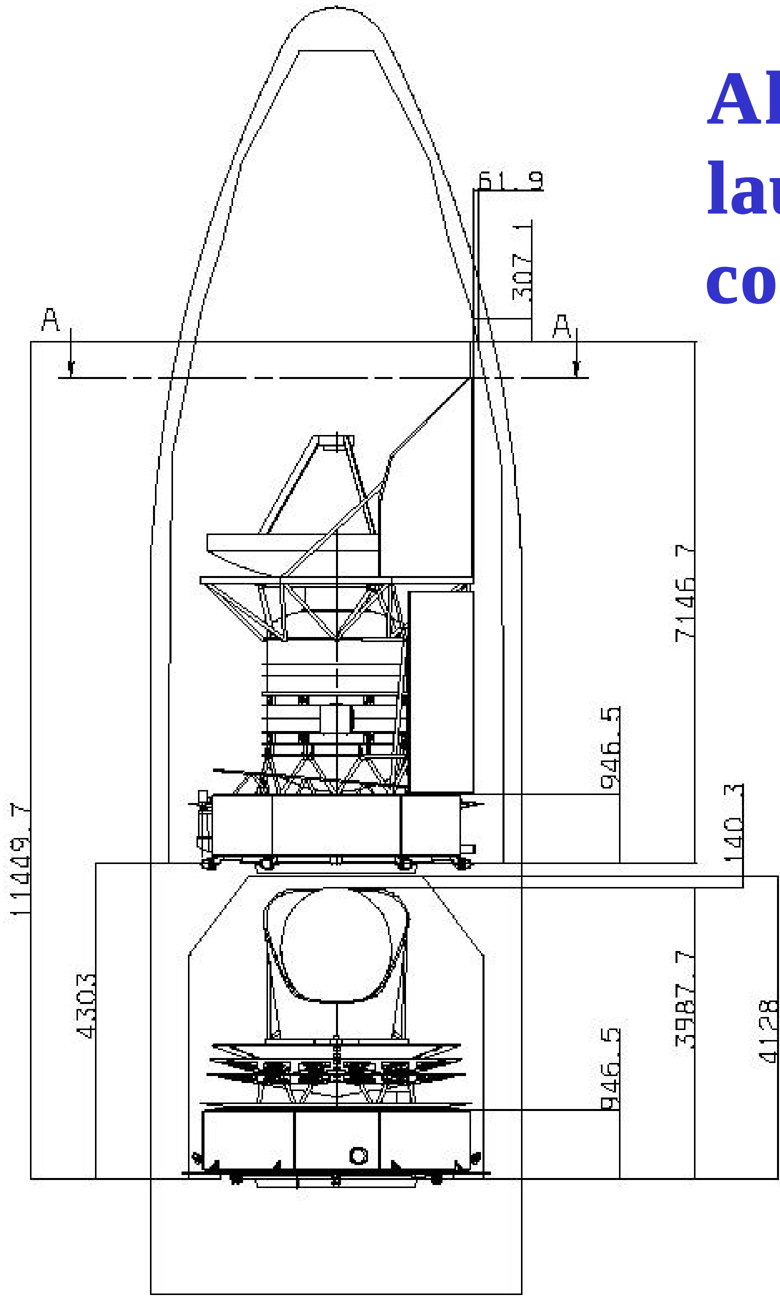
Dr. John Delderfield

RAL/CCLRC

Spire System

Dr. John Delderfield

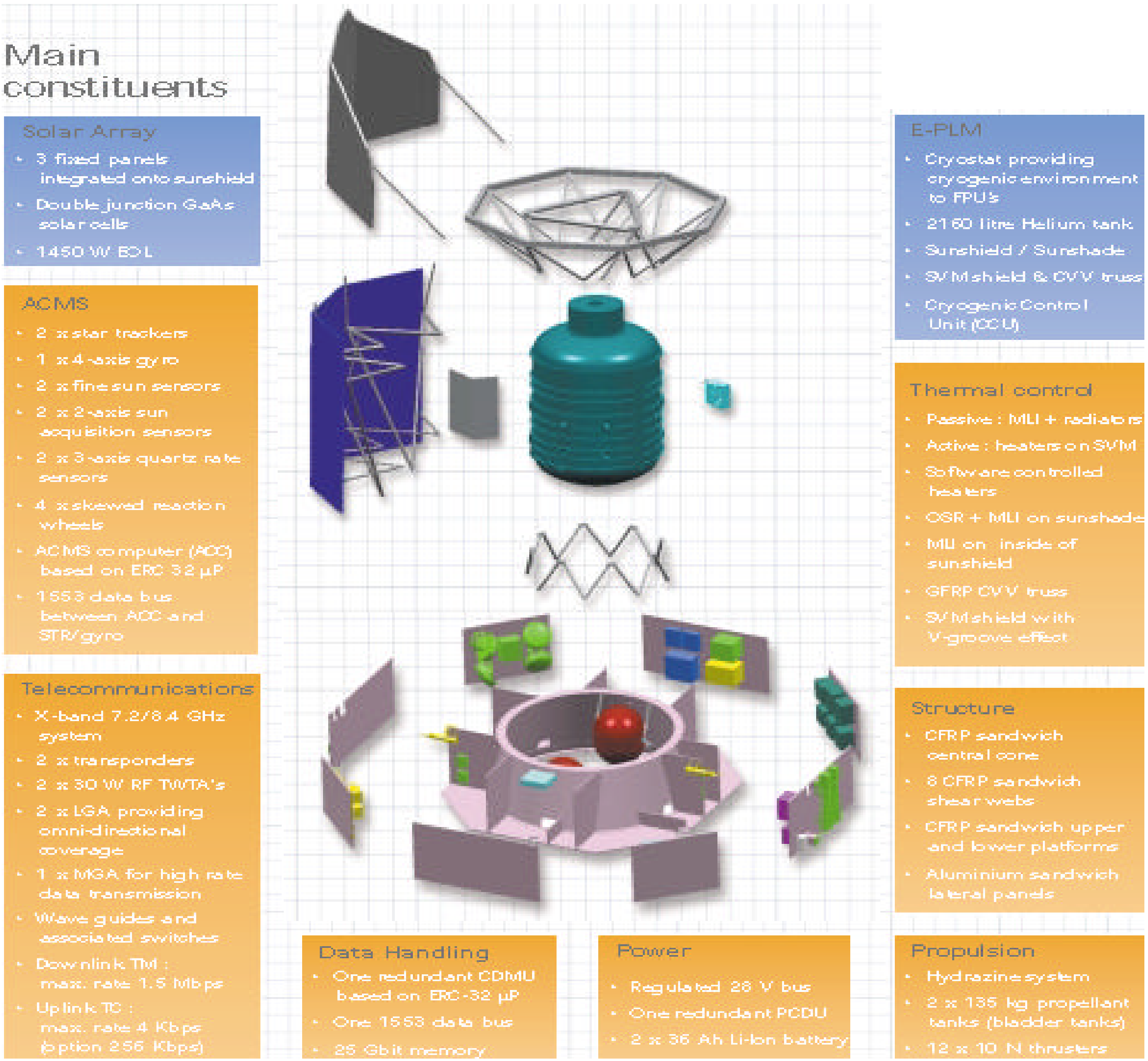




Altered launch config.

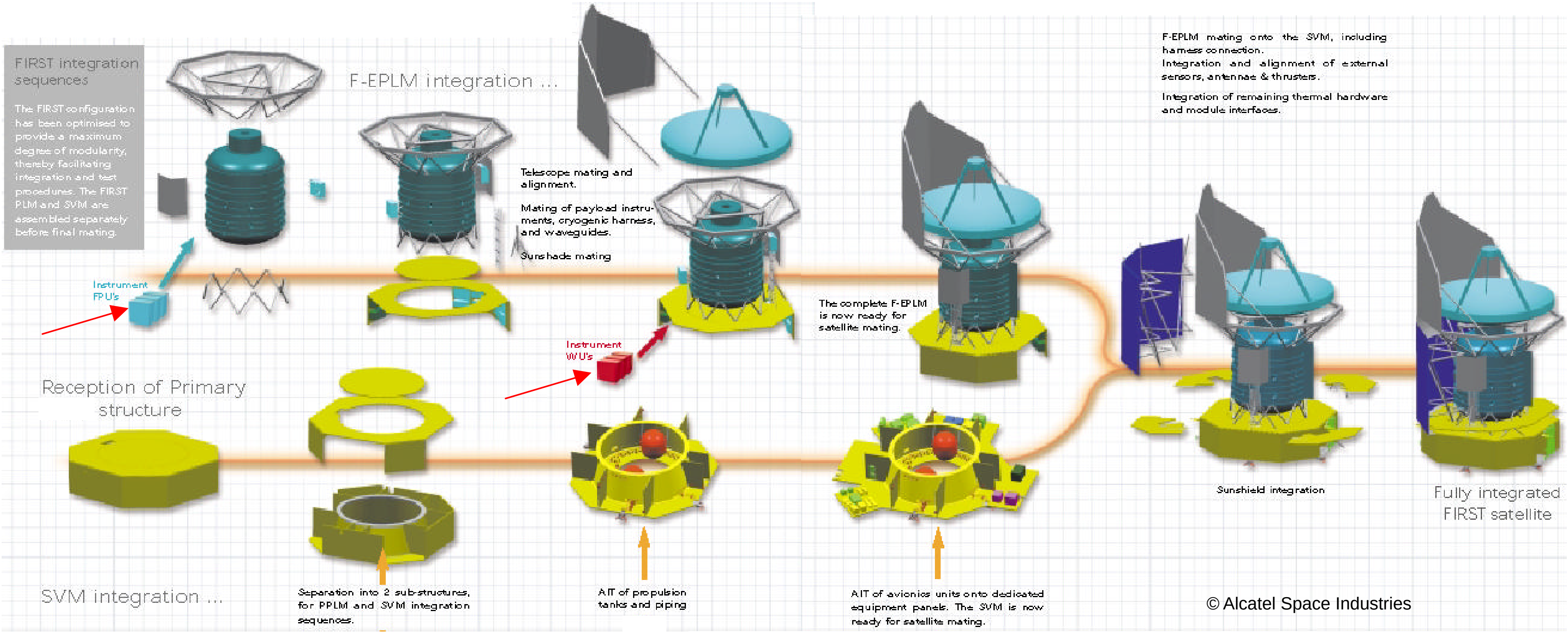
Spire System

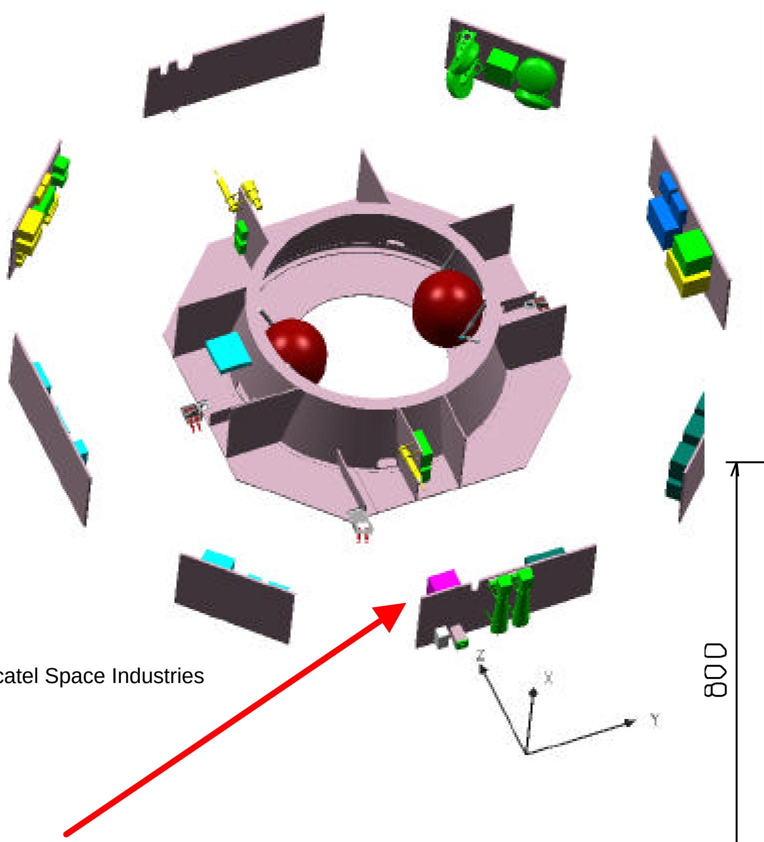
Dr. John Delderfield



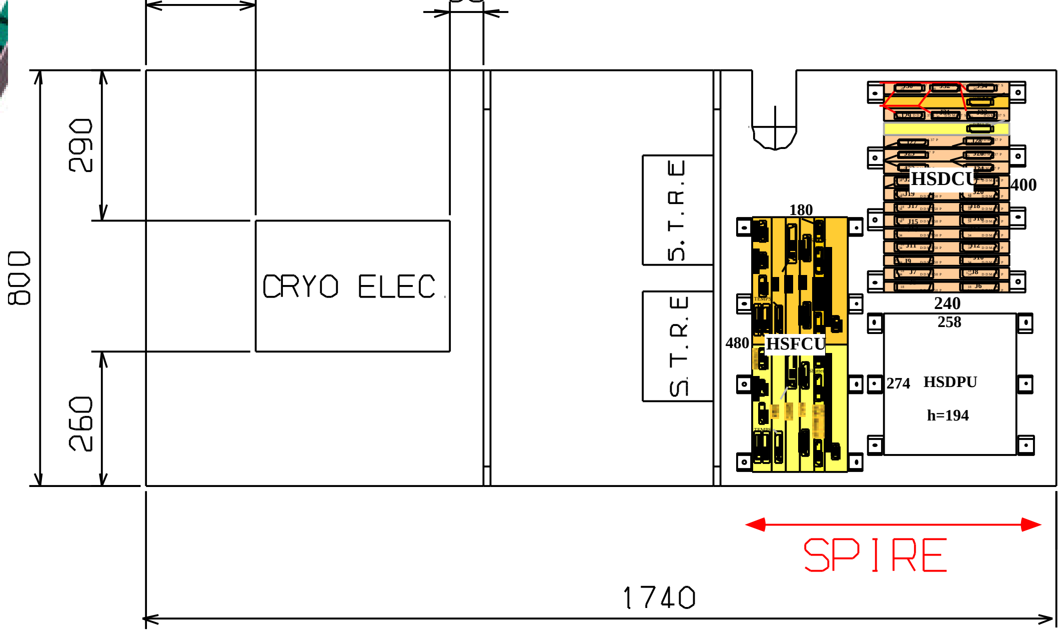
Spire System

Dr. John Delderfield

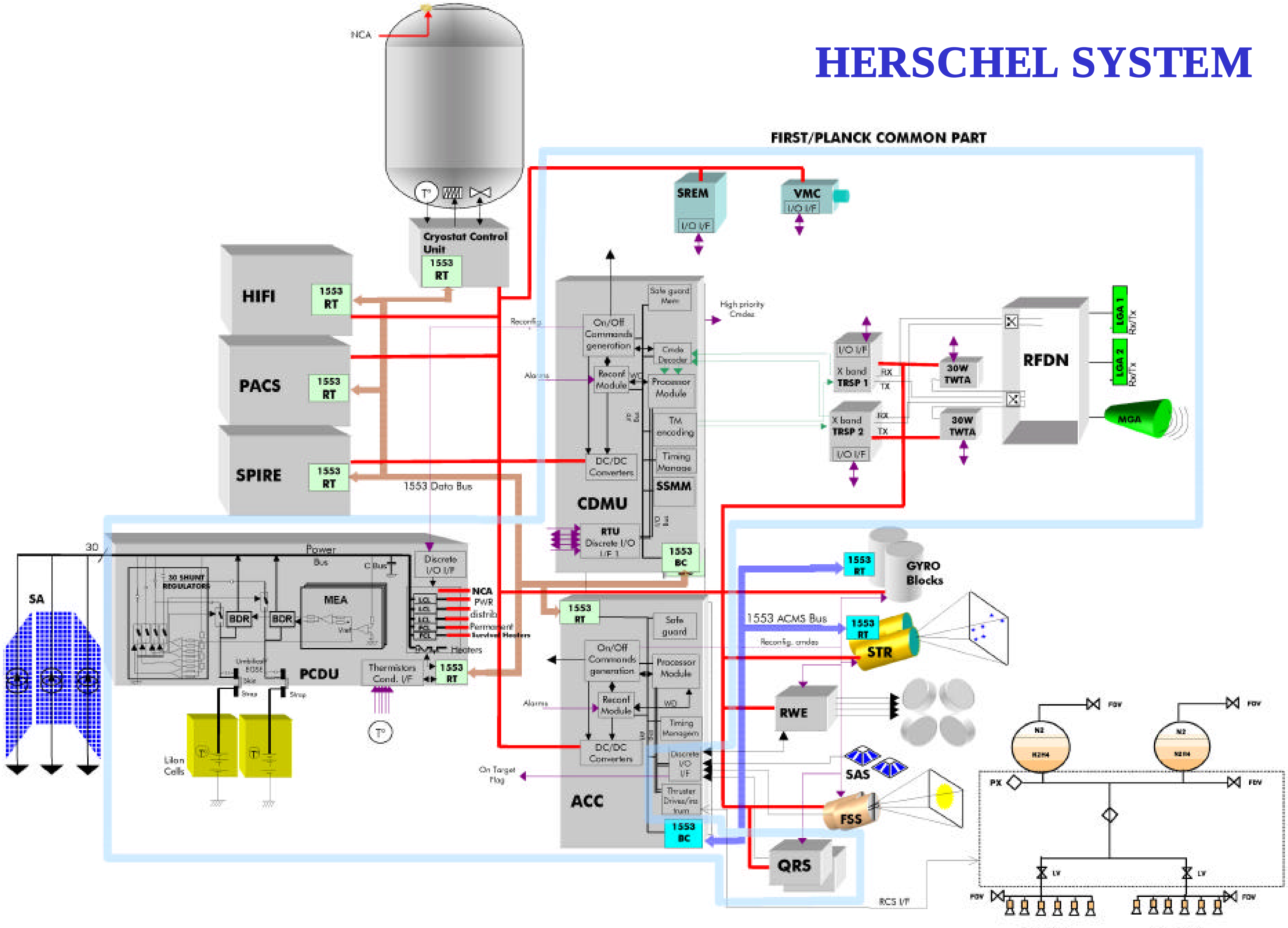




Inside of SVM -Z panel

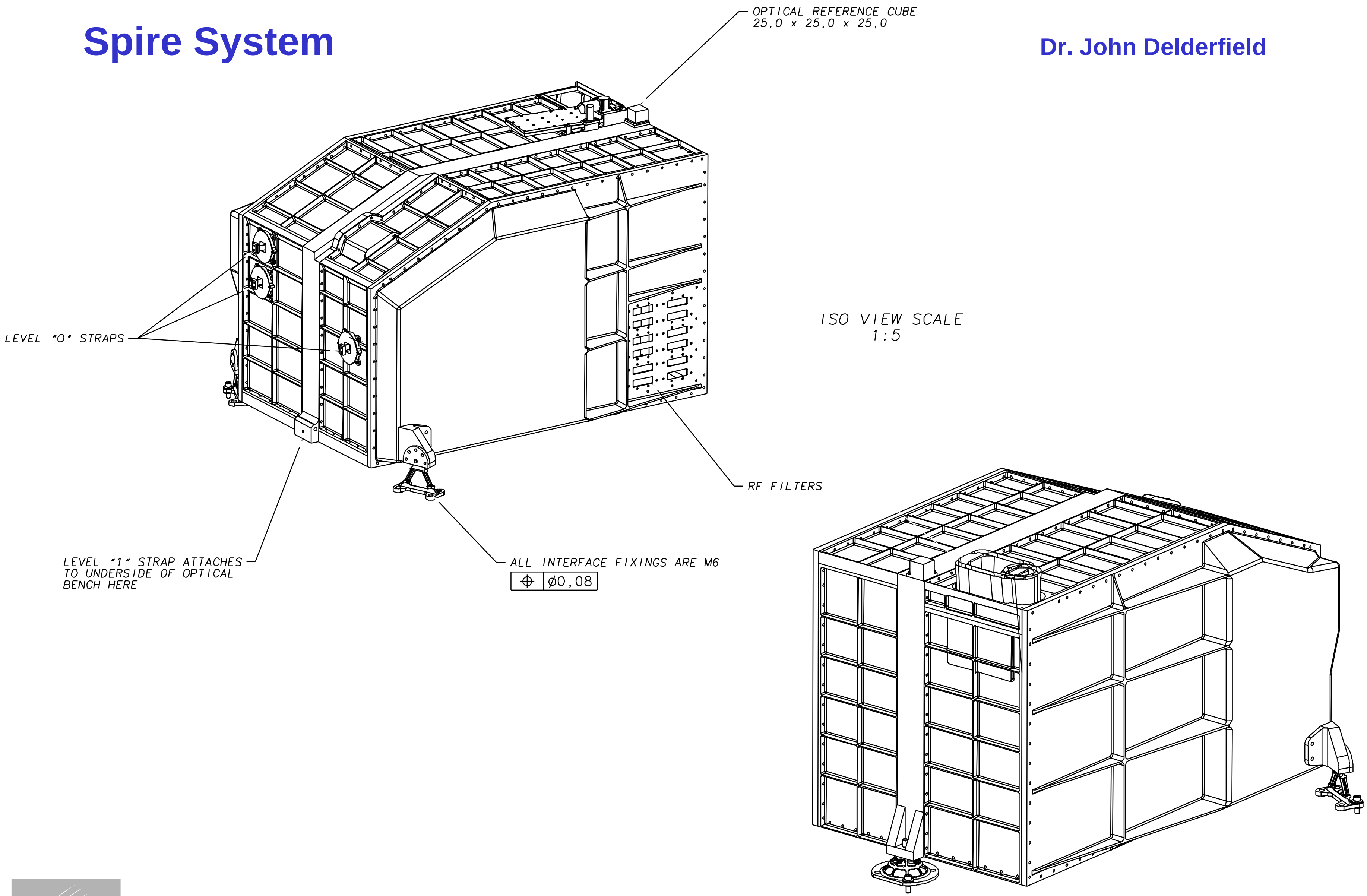


HERSCHEL SYSTEM

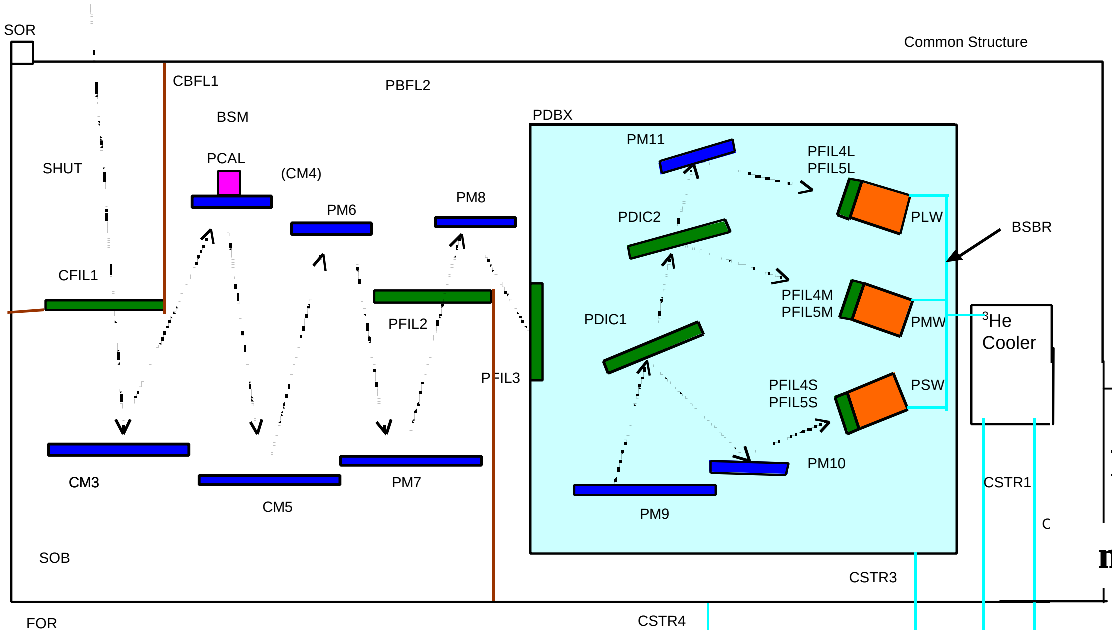


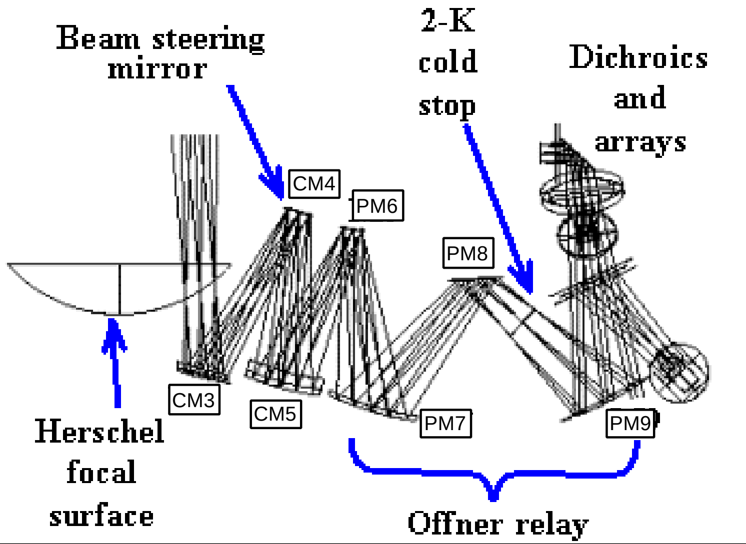
Spire System

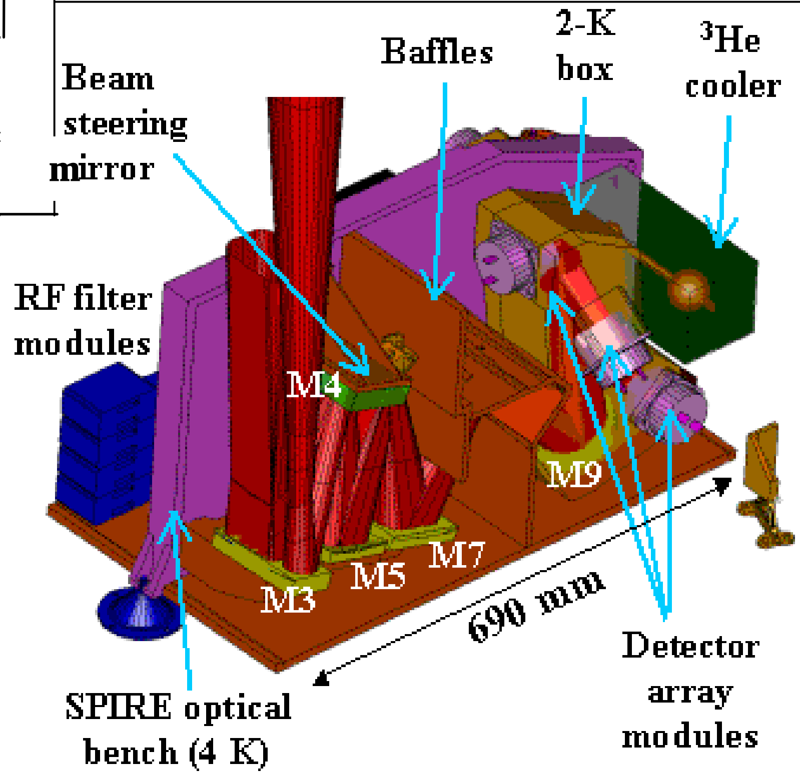
Dr. John Delderfield



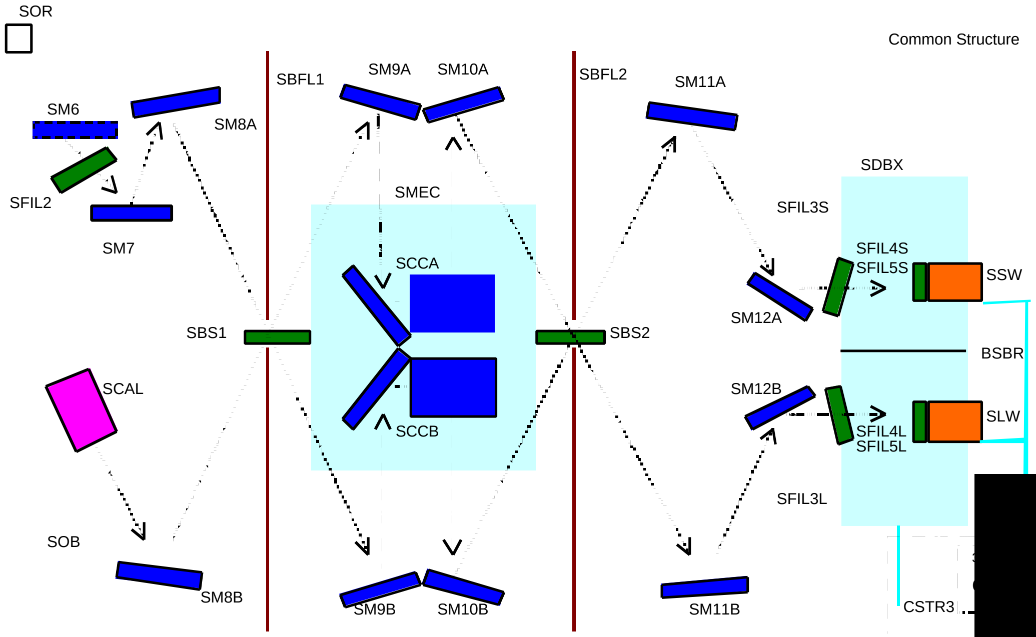
Photometer side

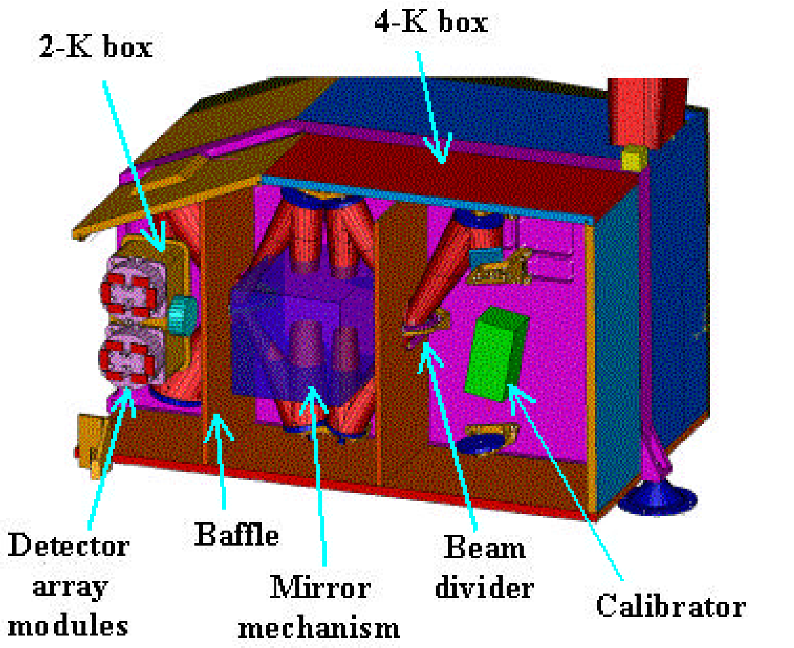


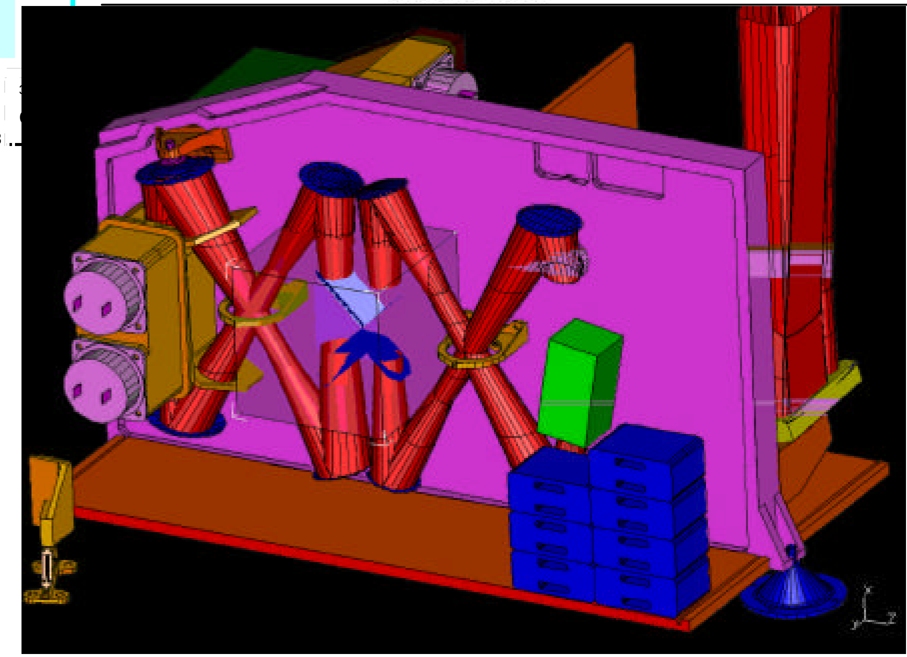




Spectrometer side







SPIRE CONFIGURABLE DOCUMENTS' TREE

SPIRE-RAL-PRJ-000033 Issue3.4 J.D. 22/6/01

ESA MIRROR / SPACECRAFT INTERFACE

- HERSCHEL/Planck Instrument Interface Document (IID) Part A
  - HERSCHEL/Planck Packet Structure Interface Control Document
  - Instrument I/F Study Final Report
  - HERSCHEL Alignment Plan
  - HERSCHEL Pointing Modes
  - HERSCHEL Telescope Specification
  - Packet Utilisation Standard.
- HERSCHEL/Planck Instrument Interface Document (IID) Part B for Spire

ESA MIRROR / GROUND SEGMENT

- HERSCHEL Science Management Plan (SMP)
- HERSCHEL Operations Scenario Document
- HERSCHEL/Planck Ground Segment I/F Doc.(GSID)
- HERSCHEL Science Operations Implementation Requirements(SIRD)
- HERSCHEL Ground Segment Design Desc.
- HERSCHEL Ground Segment Interface Requirements Doc.

ESA MIRROR /PRODUCT ASSURANCE

- PA Requirements for HERSCHEL/PLANCK Scientific Instruments
- HERSCHEL L-2 Radiation Environment

ESA MIRROR / PROGRESS REPORTS

- SPIRE PROJECT PROGRESS REPORTS

SPIRE/INSTRUMENT INTERFACE

- SPIRE Systems Budgets
- SPIRE Harness Definition
- SPIRE Optics Config. Control
- SPIRE Interface Thermal Mathematical Model (ITMM)

SPIRE Scientific Requirements (SRD)

SPIRE/INSTRUMENT REQUIREMENTS

- SPIRE Instrument Requirements (IRD)
  - Operating Modes for SPIRE
  - On-Board Software (URD)
  - TMM Specification
  - Thermal Config. Control Doc.

- SPIRE Qualification Requirements
- SPIRE Calibration Requirements
- SPIRE Optics Alignment Requirements
- SPIRE Optical Error Budgets

Note: this PA Plan, agreed at proposal, is applicable to all the SPIRE project but some equipments have chosen to evolve their own additional requirements.

SPIRE/PA

- SPIRE PA Plan

SPIRE/MANAGEMENT/MOU

- SPIRE Letters of Agreement, etc.

SPIRE/MANAGEMENT/PLANS

- SPIRE Management Plan
- SPIRE Development Plan and Model Phil.
- SPIRE Major Milestone List

SPIRE/MANAGEMENT/PLANS/ MODEL DEFINITIONS

- SPIRE STM Requirements
- SPIRE CQM Requirements
- SPIRE AVM Definition

SPIRE/MANAGEMENT/PLANS/ CONSORTIUM

- SPIRE Work Breakdown Structure
- SPIRE Sub-system/Collaborator Development Plans...multiple

SPIRE/MANAGEMENT/PLANS/ DELIVERABLES

- SPIRE Product Tree
- SPIRE Collaborators' Product Trees

SPIRE/MANAGEMENT/MINUTES

SPIRE/MANAGEMENT/DOCUMENTS

- SPIRE PROJECT SCHEDULE
- SPIRE SUBSYSTEM SCHEDULES
- SPIRE SUBSYSTEM REPORTS

SPIRE/ICC

- SPIRE Science Implementation Plan (SIP)
- SPIRE ICC Consortium URD

SPIRE/ICC/URDs

- SPIRE ICC URDs
- HERSCHEL Common Science System (FCSS) URD
- PACS/HIFI ICC Interaction URD
- Realtime Aquisition (RLA) Monitoring URD
- On-Board S/W Maintainance(OBSM) URD
- MIB Editor URD
- Astronical. Observ. Prep.URD
- Instrument Simulator URD
- Public Outreach URD

SPIRE/ICC/USE-CASES

- SPIRE ICC SummaryLevel Use Cases

SPIRE/INSTRUMENT REQUIREMENTS/ SUBSYSTEM REQUIREMENTS

- SPIRE SUB-SYSTEM REQUIREMENTS SPECS(incl S/W)
- Digital Processing Unit (DPU)
- Detector Readout and Control Unit (DRCU) [to split FCU and DCU]
- Structure incl. baffles, straps, thermometry & harness routing.
- Mirrors and Optical Stops
- Beam Steering Mirror Ass.
- Spectrometer Mechanisms
- Photometer & Spectrometer Stim.
- Filters and Beam-splitters (x2)
- Helium3 Sorption Cooler
- Detector Subsystems+ JFET modules

SPIRE/ DESIGN DESCRIPTION

- SPIRE Design Description
- SPIRE Block Diagram.
- SPIRE Grounding Phil.
- SPIRE Optical System
  - SPIRE Diffraction Analysis
- Digital Processing Unit (DPU)
- FPU ControlUnit (FCU)
- Detector Control Unit (DCU)
- Structure incl. baffles, straps, thermometry , etc.
- Beam Steering Mirror Ass.
- Spectrometer Mechanisms
- Photometer & Spectrometer Stim.
- Helium3 Sorption Cooler
- Detector Subsystems+ JFET modules
- Design Requ. Compliance Matrix.

SPIRE/GSE

- IGSE Specifications
- -EGSE URD
- -EGSE ILT URD
- -EGSE Router Spec.
- -Alignment Tools Spec.
- -MGSE
- -Analogue FPU Simulator
- -DRCU Simulator
- -SPIRE Sim. S/W Module

SPIRE/GSE/BUILD

- SPIRE IGSE Equipment Tree

SPIRE/AIV

- SPIRE AIV Plan
- SPIRE Alignment Sequence
- SPIRE Calibration Plan including COMMISSIONING and PRODUCT VALIDATION in mission
- SPIRE Ground Test Facility Specifications

SPIRE/AIT/PLANS & PROCEDURES

- SPIRE Optical Alignment Verification Plan
- SPIRE Structure Integration Plan
- Test Facility Checkout Integration, I/F checks, Vibration, EMC Thermal Balance/cycle. Calibration

SPIRE/INSTRUMENT REQUIREMENTS/ SUBSYSTEM ICDs

- SPIRE SUB-SYSTEM ICDs
- Digital Processing Unit (DPU)
- FPU ControlUnit (FCU)
- Detector Control Unit (DCU)
- Structure incl. baffles, straps, thermometry & harness routing
- Mirrors and optical stops
- Beam Steering Mirror Ass.
- Spectrometer Mechanisms (x2)
- Photometer & Spectrometer Stim. (x2)
- Filters, and Beam splitters
- Helium3 Sorption Cooler
- Detector Subsystems+ JFET modules

SPIRE /INSTRUMENT BUILD

- SPIRE Flight Equipment Tree
- Config. Status list for each model

SPIRE/INSTRUMENT OPS

- SPIRE Flight Ops. Requirements
- SPIRE Flight Operations' Manual (FOM/P)
- SPIRE Packet Formats for Commands & Telemetry (Hsk, Science, etc.)

SPIRE/AIT/REPORTS

- TEST REPORTS
- Test/Cal. Requirements Compliance Matrix
- SPIRE Calibration Coefficients

SPIRE/PA/DOCUMENTS

- SPIRE Document and Drawing Management Plan
- SPIRE Configurable Documents' Tree..this doc!
- SPIRE Configurable Drawings' Tree
- DCRs
- NCRs and MRBs
- Cleanliness
- Handling
- Reliability/FMCA

Note: The IID and ICDs are listed in priority so that an I/F between two systems is only detailed in the document listed the higher.

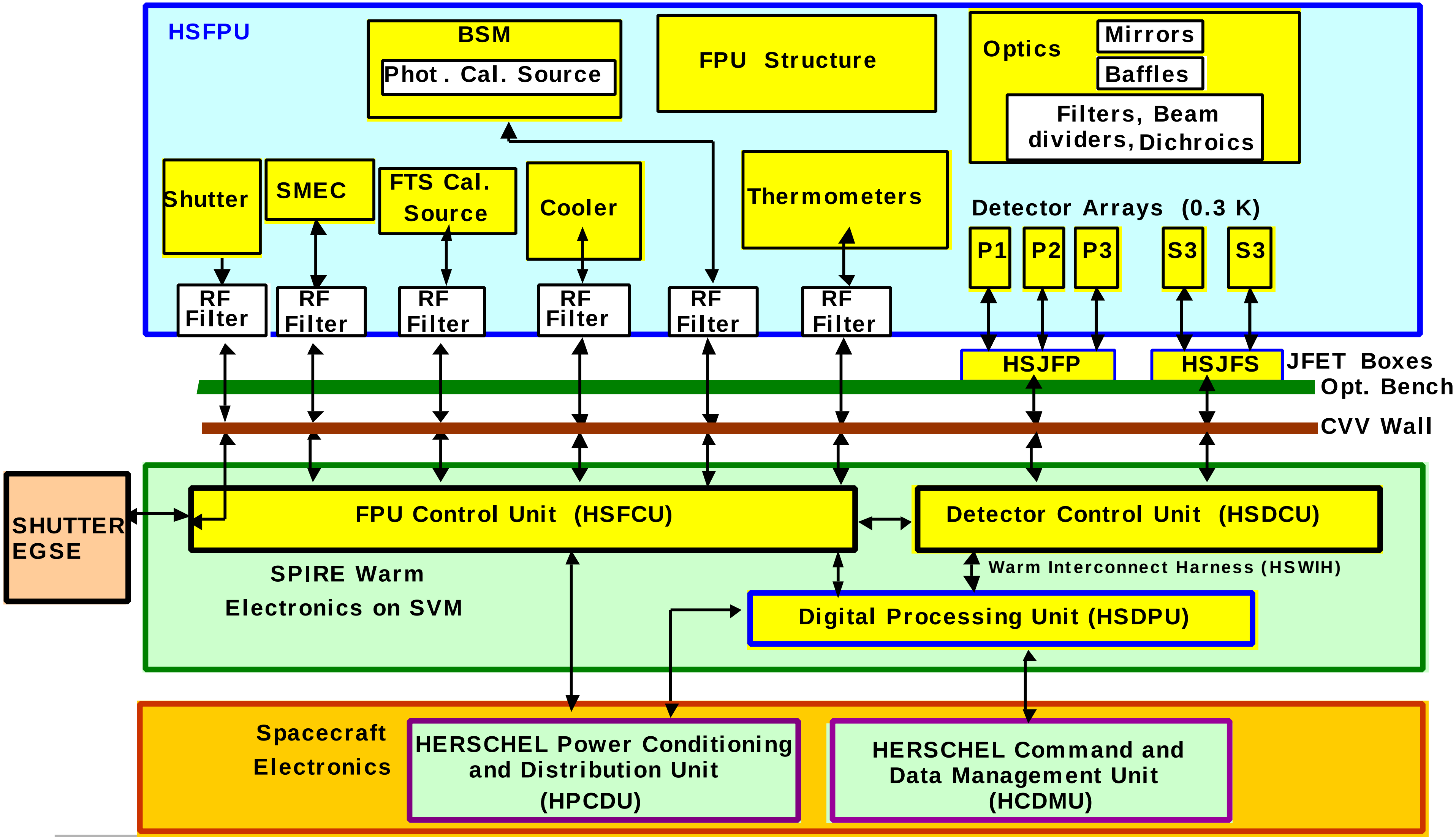
Iss 2.: Changed FIRST to HERSCHEL (even if document not yet updated). Added number for thermal document.
Iss3.: Updated and changed from DMS to LIVELINK structure...as at IIDR. The coloured zones with red names are LIVELINK FOLDERS in which to find documents.
Iss3.1: Removed Doc. numbers as they are not in Livelink listings and now find items by structure/name. Updated FCU and DCU acronyms. Update Doc. names. Define more DDs. Put "x2" if split e.g. if software and electrical documents are separate.
Iss3.2: Move IIDB Part-B into ESA Document area...are not formally issued by RAL. Iss 3.3 Add ITMM and Change word for MOU. Iss3.4 Include Minutes.

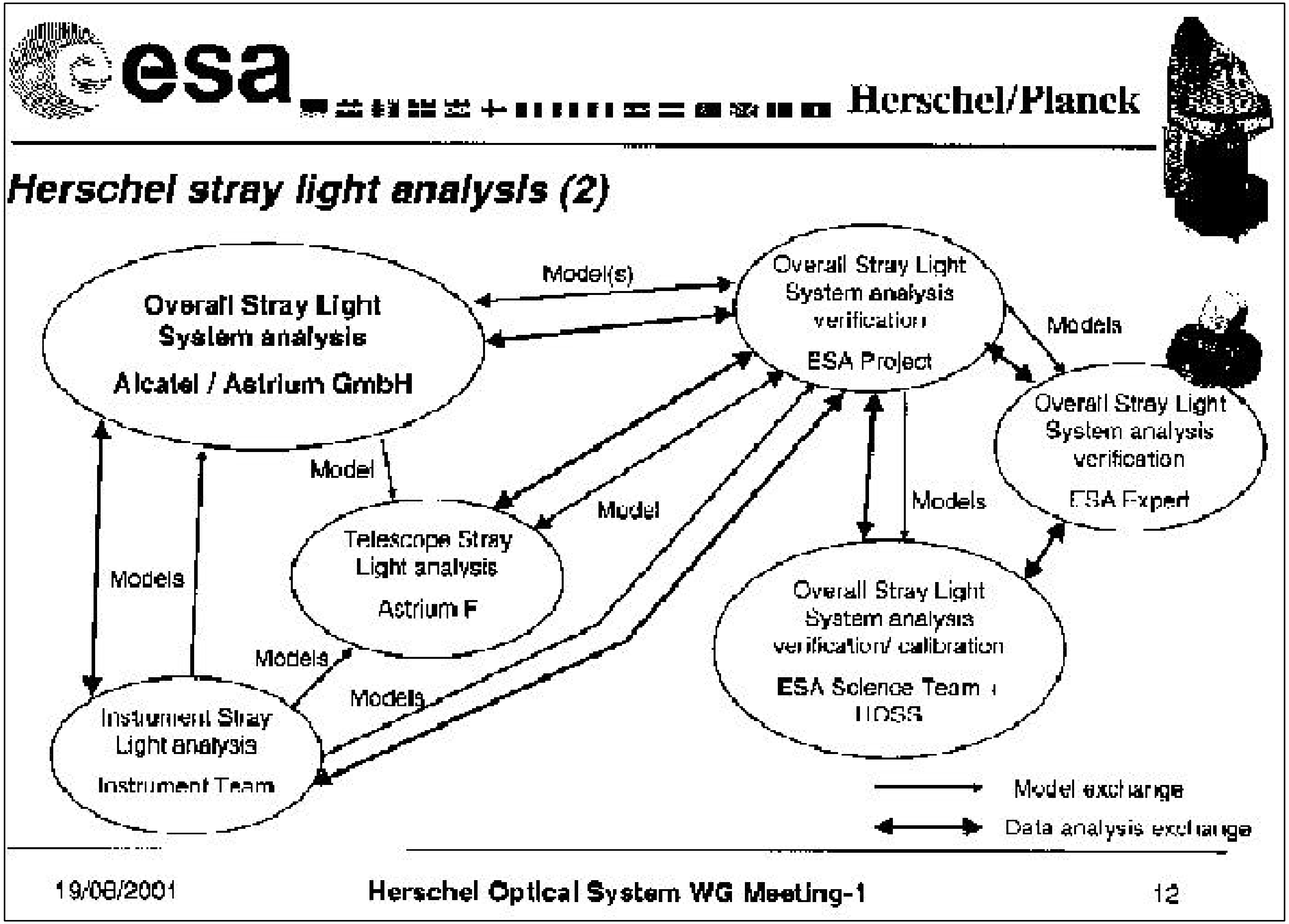
System documentation

Document	Reference		Abbreviation
SPIRE Scientific Requirements	SPIRE-UCF-PRJ-000064		SRD
SPIRE Instrument Interface Document Part B	SPIRE-ESA-DOC-000275		IID-B
SPIRE Instrument Requirements Specification	SPIRE-RAL-PRJ-000034/1.0 23 Nov. 2000		IRD
Operating Modes for SPIRE	SPIRE-RAL-PRJ-000320		OMD
SPIRE On-Board Software URD	SPIRE-IFSI-PRJ-000444		OBS URD
Subsystem Specification Documents for each of the SPIRE subsystems	Detector Subsystem Specifications	SPIRE-JPL-PRJ-456	SSSDs
	SPIRE Spectrometer Mirror Mechanism Subsystem Specification	LAM.PJT.SPI.SPT.200002 Ind 4	
	SPIRE Beam Steering Mirror Subsystem Specification Document	SPIRE-ATC-PRJ-0460	
	SPIRE Sorption Cooler Specifications	GS/SBT/SPIRE/2000-01	
	DPU Subsystem Specification Document	SPIRE-IFS-PRJ-000462	
	MCU Design Description	LAM/ELE/SPI/000619/1.1/ 20 Dec. 2000	
	SPIRE Mirrors Specification	LAM.PJT.SPI.SPT.200007 Ind 4	
	DRCU Subsystem Specification	SAp-SPIRE-CCa-25-00	
	SPIRE Filters subsystem specification	SPIRE-PRJ-000454	
	SPIRE Calibrators subsystem specification	SPIRE-QMW-PRJ-000453	
	SPIRE Structure Subsystem Specification Document	SPIRE-MSS-PRJ-0000427	
SPIRE Design Description	SPIRE-RAL-PRJ-000620		SDD

Spire System

Dr. John Delderfield




esa
Herschel/Planck
Herschel stray light analysis (2)
Overall Stray Light
System analysis
Alcatel / Astrium GmbH
Model(s)
Overall Stray Light
System analysis
verification
ESA Project
Models
Overall Stray Light
System analysis
verification
ESA Expert
Model
Model
Telescope Stray
Light analysis
Astrium F
Models
Models
Models
Models
Instrument Stray
Light analysis
Instrument Team
Overall Stray Light
System analysis
verification/ calibration
ESA Science Team +
HOSS
Model exchange
Data analysis exchange
19/06/2001
Herschel Optical System WG Meeting-1
12

Information/ Document Control Form

HERSCHEL
SPIRE

Action Sheet

Number 2
Issue Date 03-Jul-01

Originator

Delderfield J

RAL

Due_Date 01-Sep-01

Status

Open

Actionees

Actionees	Organisation	Action Status
Brown H	MSP	Open

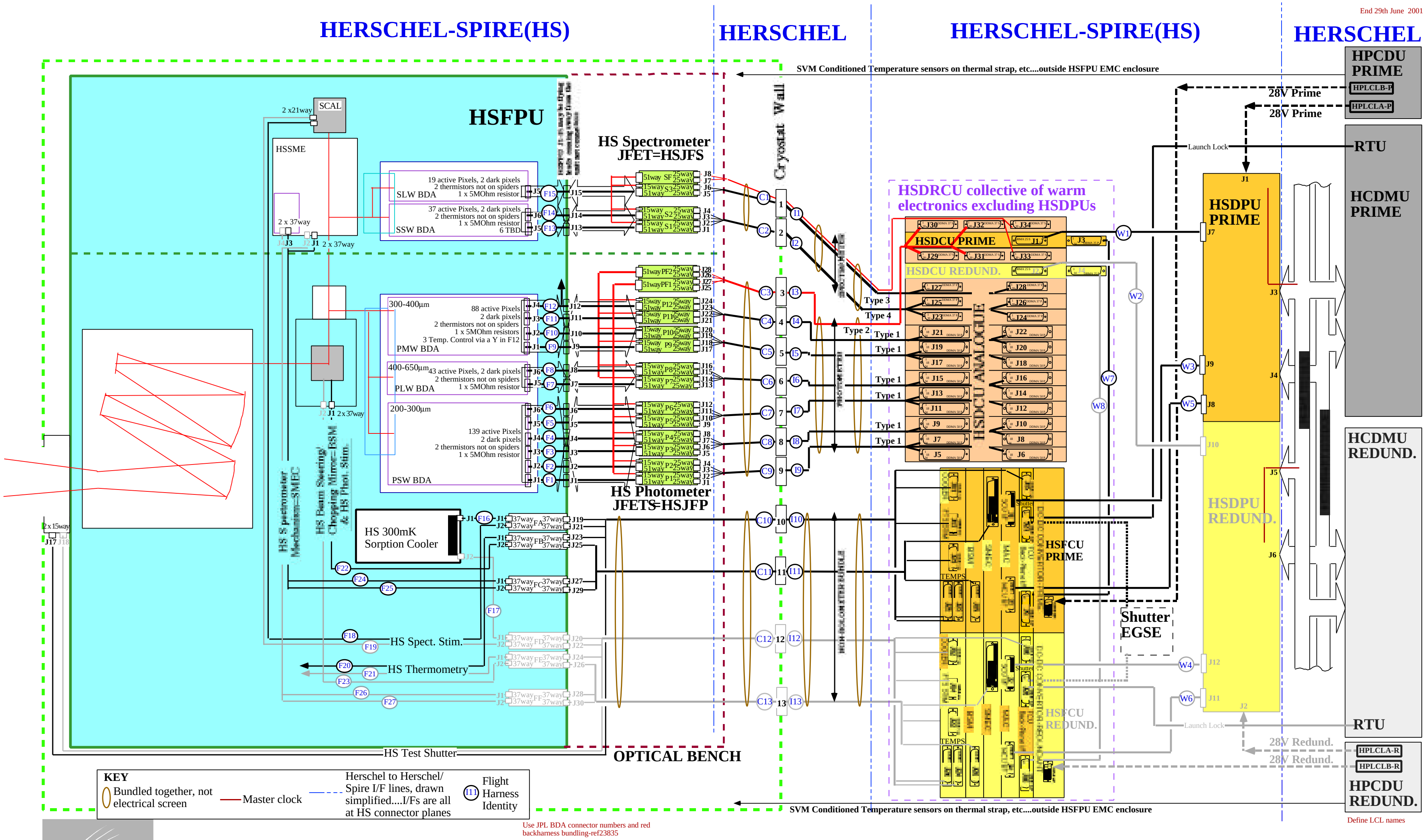
Referenced Documents

Number					Issue	Date	Title
S1	EST	EST	ED	3001	4	17-Apr-01	ED-A

Mass budget contingency data to be included in Table 7.1

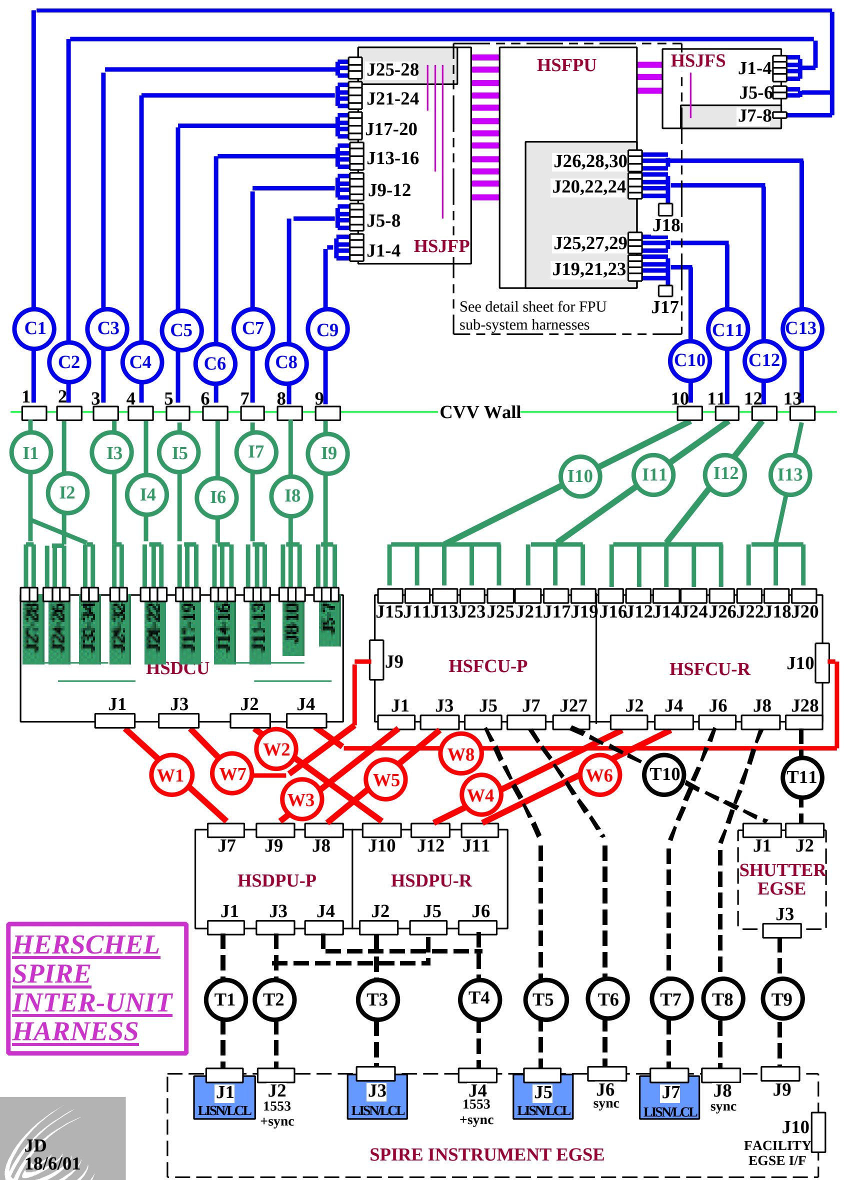
Spire System

Dr. John Delderfield



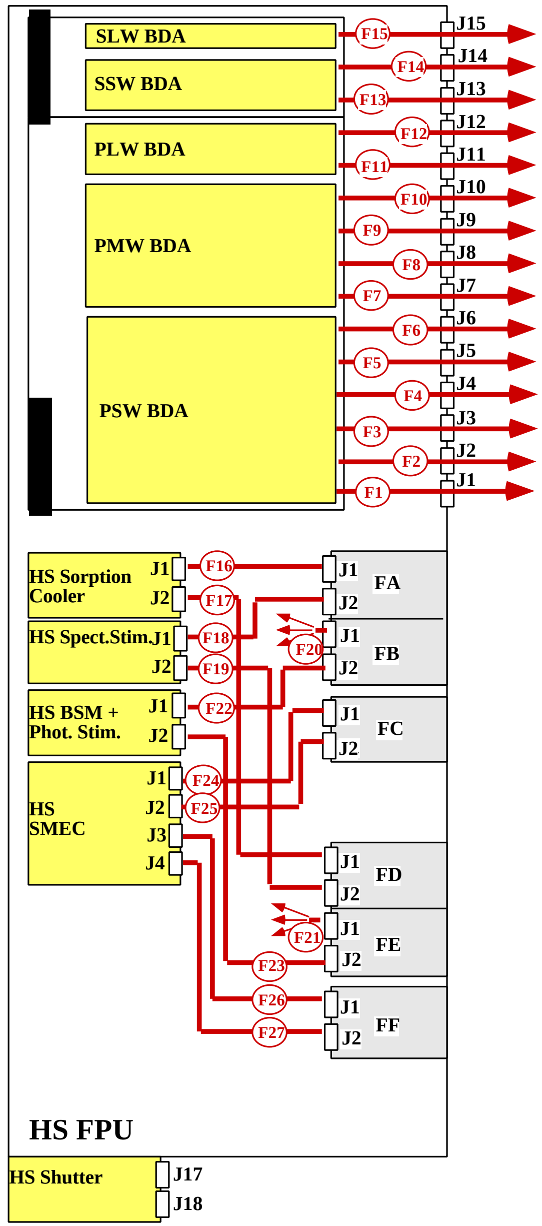
Spire System

Dr. John Delderfield

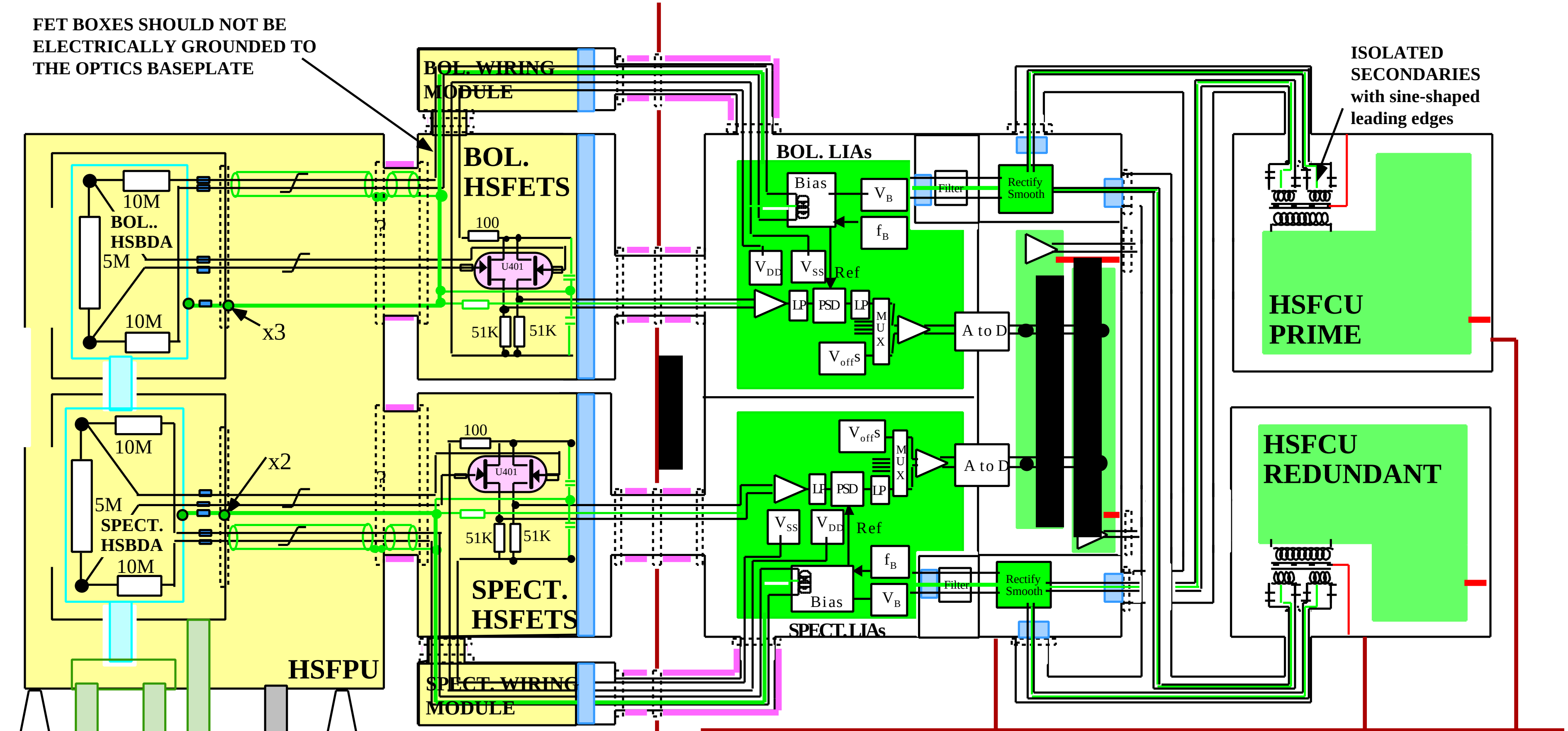


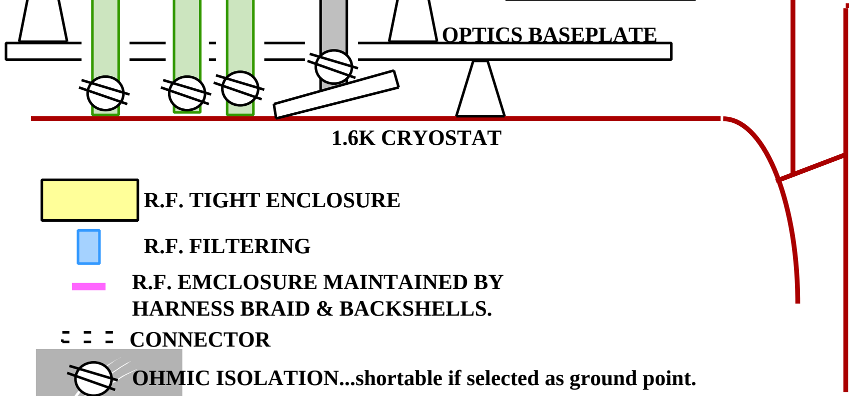
Note:
J1-J15 FPU connectors are baselined as being replaced with cable to wall feedthrough via two interface plates. So F1-15 needs outer r.f. screens from this I/F to the JFET boxes but not necessarily from the I/F inwards.

HERSCHEL SPIRE FPU INTER-SUBSYSTEM HARNESS



JD 18/6/01





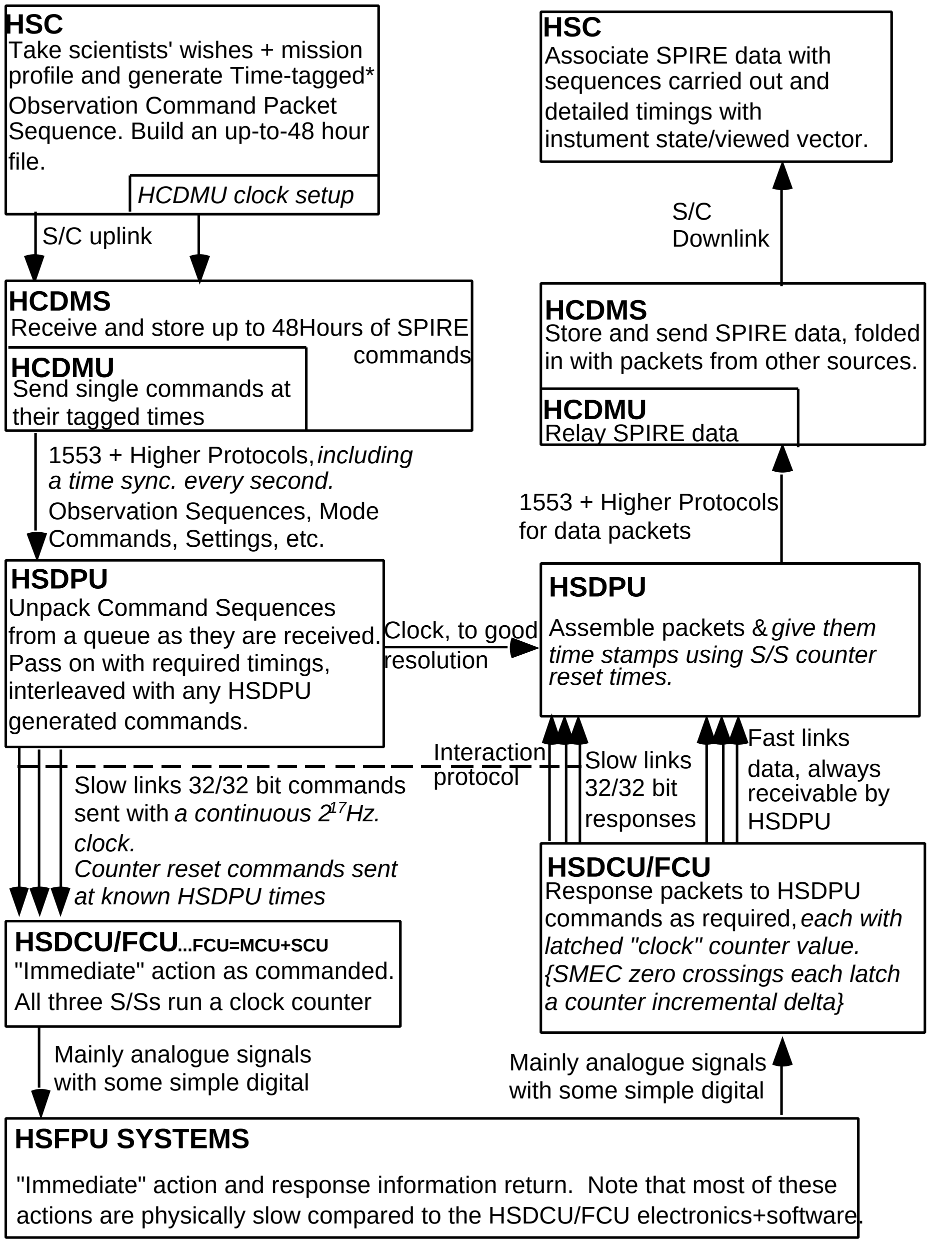
SPIRE DETECTOR OUTLINE GROUNDING DIAGRAM

NOTES: There are two separately grounded analogue sections, one for the spectrometer and one for the bolometer channels. This is because the sensitivity of the bolometers and the physical separation of the two JFET boxes, arranged to minimise the all important capacitive loading of leads on the 5MOhm bolometers.

The high level of signals on the biases and the distribution of cryogenic harness contacts cause the biases & FET supplies to be routed through different leadthroughs in the 80K cryostat wall from the balanced channel signals, although the harnesses should be bundled together to minimise loop area. There is a resistor shown for each ground section in each groundloop, which requires to be of optimum value.

There is not quite a classical unipoint for each ground but rather a joining to each BDA 2K section within the r.f. free enclosure, TBC by modelling.

SPIRE DATA TIMINGS



SPIRE

Instrument Level Criticality Analysis

Bruce Swinyard
RAL

SPIRE

Instrument Level Criticality

- Take each sub-system and assume it may encounter problems in-flight - then ask the questions:
  - **What would happen if this wasn't working at at all?**
  - **What would happen if this wasn't working very well?**
  - **Can we carry out the scientific programme under one or other circumstance.**
- We also asked a sharper question to determine criteria for warming up the cryostat during system level integration
  - **Would we fly without this subsystem**
- We do not ask where the failure might happen or whether it is likely
- We wish to know which are the mission critical sub-systems to identify where effort and resource should be used for redundancy and to identify backup operational modes

SPIRE

Cooler/300 mK System

Failure mode	**Consequence**	**Remedial Action**	**System Level Redundancy**
Loss of ^3He cooling	Total loss of instrument	None	None
Partial loss of ^3He cooling (ineffective or inefficient recycling; abnormal thermal load at 300 mK etc etc)	Possible operational constraints if large impact on lifetime.	Load on 300 mK is essentially all parasitic. The only remedial action is to recycle the cooler more often and, if mission lifetime is to be maintained, to use SPIRE less frequently.	Fully flexible operations.

SPIRE

Photometer Detectors

Total loss of short wavelength array	Same science can use PACS LW band but survey will take longer. Possible to use spectrometer but with much reduced sensitivity	Use spectrometer for point source photometry	PACS LW band
Total loss of medium wavelength array	The same science can be done using SW and LW bands but with reduced fidelity.	Ditto	None necessary
Total loss of long wavelength array	Long wavelength photometry mapping lost for whole of FIRST	Ditto	None
One pixel fails	Slight increase in jiggle chop mode complexity to achieve fully sampled FOV If one of the prime pixels is lost then point source observations are less efficiently carried out.	Use BSM to fill in for missing pixel if required by observation.	Four “prime” pixels in each array
One block fails	Depending on the size of the block will have to use full chop throw of BSM or use satellite Scan mode - loss in sensitivity	Use satellite and BSM together if greater than 2 arcmin	Little flexibility in arrangement of pixel wiring

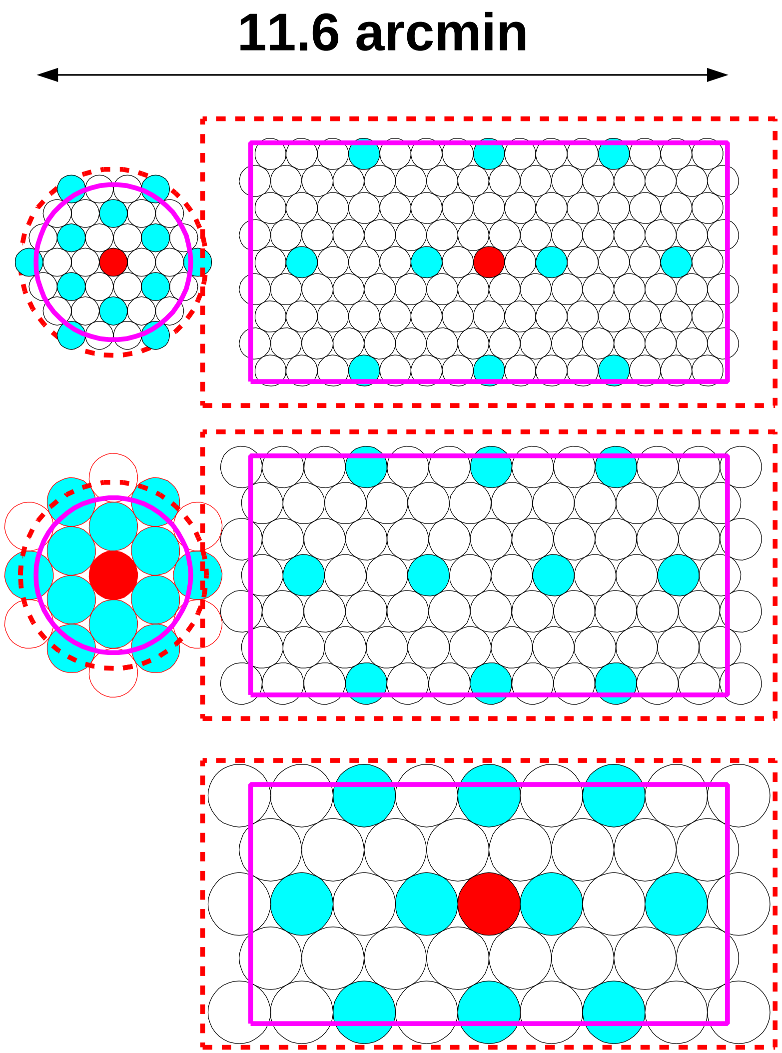
SPIRE

Spectrometer Detectors

Loss of short wavelength array	Total loss of low/medium resolution spectroscopy on FIRST in 200-300 micron waveband	None	HIFI may cover this range
Loss of long wavelength array	Total loss of low/medium resolution spectroscopy on FIRST in 300-400 micron waveband	None	HIFI will cover this range
Loss of any one pixel	If centre pixel then will have to nominate off axis pixel as "prime". Possible loss of sensitivity and spectral resolution using off-axis pixel Obtaining a fully sampled image will be more difficult.	Offset pointing of satellite from on-axis beam More complicated jiggle mode BSM operation to fill in for missing pixel.	Many pixels. (see note 3)
Loss of any block of pixels	If whole array is a single block then total loss of this channel Very difficult/slow to obtain fully sampled image.	Offset pointing of satellite from on-axis beam Nod satellite to fill in missing block for mapping.	Two blocks in SW array – only one for LW array.

SPIRE

Pixel Layouts



Spectrometer SW 2.25 mm pixels

Photometer SW 2.5 mm pixels

Spectrometer LW 3.897 mm pixels

Photometer MW 3.33 mm pixels

Photometer LW 5 mm pixels

BSM

Total loss	All jiggle/chop modes lost	Use scanning to fully sample FOV Satellite nodding used to remove any telescope temperature drift and for chopping for extended sources Satellite fine raster mapping used for sampling for feedhorn arrays	Two axes in BSM – total failure less likely Bias modulation is implemented. Satellite operations
Mirror stuck at extreme chop position	If the mirror fails at its extreme chop position in the +Y direction and cannot be recovered there will be a loss of part of the photometer FOV. If it fails in the extreme –Y direction there will be total loss of the spectrometer FOV.	Use unvignetted portion of array with loss of efficiency. No recovery if spectrometer FOV	A launch lock must be fitted to prevent extremes of movement.
Partial Failure	Depends on failure mode: Possibility of loss of one axis		

SMEC

Total loss	Loss of all low /medium resolution spectroscopy on FIRST	None	HIFI covers part of wavelength range
Partial failure	Reduction in use of spectrometer Loss of higher or lower spectral resolution Increased systematic noise Increase in straylight from higher temperature motor	Change method and/or frequency of operation slow mirrors down or, in extremis, go to step and integrate using BSM to modulate signal	Flexible operations – well defined backup modes

SPIRE

Calibrators

Total loss in PCAL	Calibration may be slower leading to possible loss in instrument efficiency	Set up network of secondary astronomical calibration sources over as much of sky as possible.	Secondary astronomical calibrators
Total loss in SCAL	No compensation for telescope background Increased systematic noise on low resolution spectra Dynamic range limit hit on amplifiers/digitisation Loss of automatic absolute calibration – calibration will be slower leading to loss in instrument efficiency	Sufficient dynamic range in to cope with signal. Methods to reduce data rate will be required as will now need 16 bits to encode detector signals In extremis go to step and integrate using BSM to modulate signal.	Flexible operations – well defined backup modes

Mission Critical Areas

- Total loss of the cooler
- Structural failure in the 300-mK system leading to thermal short
- Total loss of the photometer long wavelength array
- Total loss of either spectrometer array
- Total loss of the FTS mirror mechanism
- Additionally the if the BSM fails in at full throw in the -Y direction the spectrometer FOV becomes highly vignetted - a launch stop must be fitted to prevent this

Backup Modes

- More frequent cooler recycling including the possibility of autonomous recycling under control of the DPU alone.
- Slow chop mode in the event of partial BSM failure
- Open loop BSM control using commanded current to the actuators
- Single axis BSM operation
- Slow scanning of FTS mirrors
- Step and look operation of the FTS in conjunction with the BSM
- Open loop operation of the FTS mechanism by commanding the current to the actuator
- DC operation of photometer calibrator this will allow V-I's on detectors under different loadings for calibration
- Selection of smaller numbers of detectors from photometer arrays in event of telemetry bandwidth problems
- Selection of smaller number of spectrometer detectors in event of problems with telemetry bandwidth and/or loss of spectrometer calibrator

SPIRE

Warm up(i)

- **We asked another question:**
  - **Under what circumstances would the cryostat be warmed up in the event of a failure in an instrument FPU?**
- **Two categories of failure**

A. **Major failure that of itself demands warm-up: assigned a score of 100% warm-up**

B. **Less serious failure that of itself would not justify warm-up but might do so if there were also other other failures (in any of the instruments): assigned a score of x% warm-up where SUM(x)=100% for a warm-up to be justified**

Warm up(ii)

Subsystem	Consequence of major failure in-flight	Seriousness of failure in cryostat on ground (% warm-up)	Priority for Flight Spare
^{3}He cooler	Very Serious Total loss of SPIRE	100	Very High
Shutter	Very Serious Total loss if fail closed	100	Low
Photometer 250 mm Array	Serious Loss of band unique to SPIRE	40	High
Photometer 350 mm Array	Moderate Loss of intermediate band between 250 and 500 mm	20	Medium
Photometer 500 mm Array	Serious Loss of band most sensitive to high-z galaxies	40	High
Spectrometer SW Array	Serious Loss of 200-300 mm band unique to FIRST	40	High
Spectrometer LW Array	Serious Loss of main portion of FTS range	40	High

SPIRE

Warm Up (iii)

Subsystem	Consequence of major failure in-flight	Seriousness of failure in cryostat on ground (% warm-up)	Priority for Flight Spare
Beam Steering Mechanism	Serious Significant loss of efficency for point (~7) and compact sources (~2)	20	Medium
FTS Mechanism	Serious Total loss of FTS	70	High
FTS Position Sensor	Moderate Loss of low-res. FTS mode	30	Medium
Photometer Calibrator	Low Inefficent in-flight calibration	20	Low
Spectrometer Calibrator (Hot)	Low Less effective nulling of telescope spectrum	20	Low
Spectrometer Calibrator (Cold)	Moderate Loss of low-resolution FTS mode	30	Medium
Thermometry	Low Loss of instrument diagnostics	10	Low

SPIRE ICC Status

Marc Sauvage
CEA/DSM/DAPNIA/SAp

The ICC in the Herschel context

- ICC stands for Instrument Control Center.
- The ICCs are an essential part of the Herschel project, both in the development and in the operational phase (and probably in the post-operational phase as well).
- Defining what the ICC will be is a complex process that involves interaction with the SPIRE consortium and instrument team on one side, and the Herschel Science Center (HSC) on the other.

Missions of the ICC (dev.)

From the instrument

- Provide analysis tool for test
- Participate in observing mode and strategy definition
- Prepare quick-look and interactive analysis tools
- Define and participate in calibration
- ...

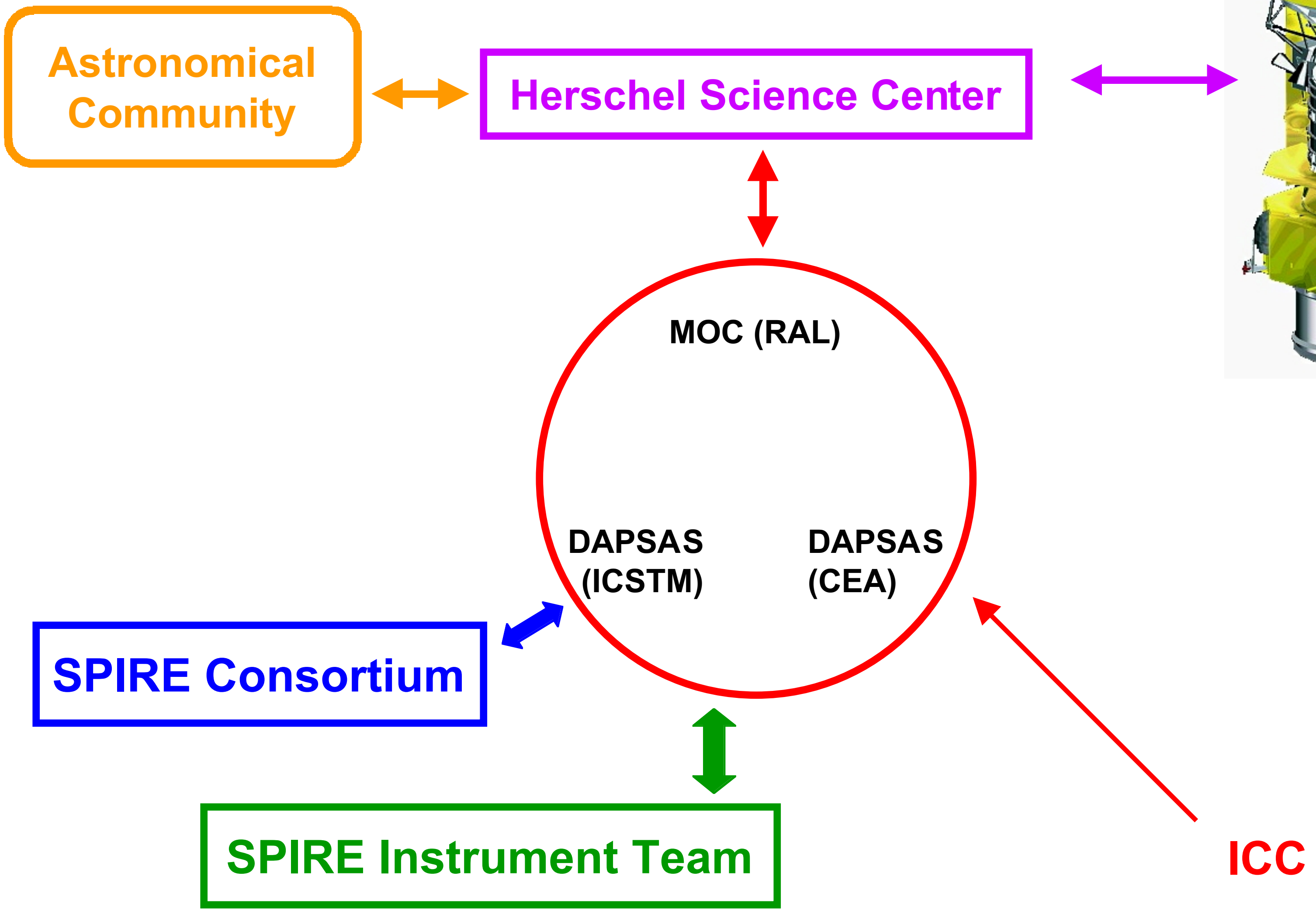
From the project

- Provide instrument command sequence
- Participate in the definition of databases
- Participate in the definition of the common uplink system
- Participate in the definition of common observatory tools
- ...

Missions of the ICC (operations)

- Operate the instrument on a daily basis
  - Define calibration plan and implement it
  - Monitor the instrument behavior
  - Monitor the science quality of the data
  - Analyze/Solve operational problems
- Improve instrument calibration
- Design/Improve data reduction algorithms
- Investigate large-scale science quallity problems
- Participate in the scientific analysis of SPIRE GT programs

Structure of the ICC



ICC development

We think we know what we have to do, we need a method to build that system and at the same time make sure it will fulfill our needs.

- Classical method:
  - Identify all the users of the system
  - Have them describe what the need
  - Collect all these requirements
  - Design and build the system

- Object-Oriented method:
  - Assume the system exist
  - Describe all possible way you want to use it
  - Collect these “Use-Case” and break them down in elementary uses
  - Design and build the system from these functions

⇒ From their first principles, the two methods are not compatible...

ICC development

- Classical method:
  - + most of the ICC members are familiar with it.
  - - we need some a-priori knowledge of the system to find its users.

- Object-Oriented method:
  - + requires no a-priori knowledge of the system.
  - + a use-case is a relatively simple concept to grasp.
  - + it is more flexible.
  - + it is easier to use to define work packages.
  - + It is the system design method chosen for the HCSS.
  - - most ICC members are new to this way of thinking.

ICC development

- We have started with the user requirement method:
  - We are more familiar with it.
  - It is relatively simple to guess who the users are from the ICC structure.
- From the collection of requirements we define a number of summary-level use cases:
  - Summary level means they describe general actions and therefore they are still relatively compatible with the user requirement approach.
- Summary-level use-cases are broken down into their elementary actions (the user-level use-cases)
- This collection of user-level use-cases leads to both the system definition and the generation of actual work-packages.

ICC development status

Version 2 of the complete list of User-Requirement Documents has been produced (it contains 224 individual requirements).

543	AIV requirements (ILT, IST etc)	Ken King
544	Calibration requirements	Seb Oliver
545	Photometer processing	Walter Gear/Seb Oliver
546	FTS processing	Jean-Paul Baluteau
548	Instrument engineering	Gillian Wright
549	ICC as a whole system	Neal Todd (Steve Guest)
550	Herschel Science Center	Neal Todd (Steve Guest)
551	Common Uplink System	Sunil Sidher
552	Astronomical Observation Prep.	Marc Sauvage
553	On board software	Sunil Sidher
554	Instrument operation	Gillian Wright
554	SPIRE consortium	Seb Oliver
555	MOC	Sunil Sidher
556	Other ICCs	Marc Sauvage
557	Public	Seb Oliver

ICC development status

Draft 2 of the Summary-level Use-Case document has been produced (it contains 35 Use-Cases, as a comparison the HCSS has 23 summary-level use-cases).

Generate and validate command sequences	Update the MIB	ICC and DAPSAS computing interface
Update OBS	Get a command sequence definition from instrument team	Maintain computing environment
Access data storage	Test and validate observing modes	Maintain ICC web page
Test script validatiion	View schedules of the CUS	Out of hours call out
Instrument database validation	Simulate instrument performance	Store an artefact locally in ICC/DAPSAS
Run time estimator	Investigate external SC/instrument effect on SPIRE instrument	Manage the ICC
Update Instrument Calibration	Store analysis data	Create ICC Documentation
Generate calibration report	Training in software tools	Instrument – OBS groups information interface and logging
Consortium expert knowledge capture	Support HSC query	Test and validate OBS
Evaluate/integrate ICC-external algorithm	Create or update a software artefact(s) (within the ICC)	Report an OBS problem
Disseminate knowledge	Create or update a document	Interface for joint-ICC areas of commonality
Supply ICC information to consortium	ICC and DAPSAS database access	

ICC development status

Question: How do we know we are complete and on the right track?

- **Cross-check our documents internally**: the URD and the Use-Cases Document relate to the same system so one can review their consistency
  - Take each use case and check which requirement have to be fulfilled for the action to be performed
  - Use-case that lead to functions not covered in the URD create new requirements.
  - Requirements that are connected to no Use-Case likely indicate a missing use-case.

- *Relations of the ICC with the instrument team need to be more clearly defined.*
- *Some of our summary level use-case are user-level.*
- *We miss use cases involving actual analysis of the data.*
- *The question of simulators within the ICC needs further work.*

ICC development status

Question: How do we know we are complete and on the right track?

- Cross-check our documents externally: A number of non-SPIRE entities expect the ICC to meet requirements. Mainly this is the Herschel Science Center, through the Science Implementation Requirement Document (SIRD).
  - Take each requirement of the SIRD and check that is is covered correctly by requirements in the ICC URD.
  - Make sure that SIRD requirements that are not covered by the ICC URD are in fact requirements on HCSS tasks.

Missing input from Seb on the result of this exercise

ICC development - current work

- Prepare the URD for a version 3 following the results of the UC-UR cross-check
- Include the missing use cases revealed by the UC-UR cross-check
- Include the new requirements from the SIRD-URD cross-check
- Break-down the use-cases into the user-level use-cases
- Define the work packages from the user-level use-cases.

SPIRE
ICC Development Plan

Ken King

RAL

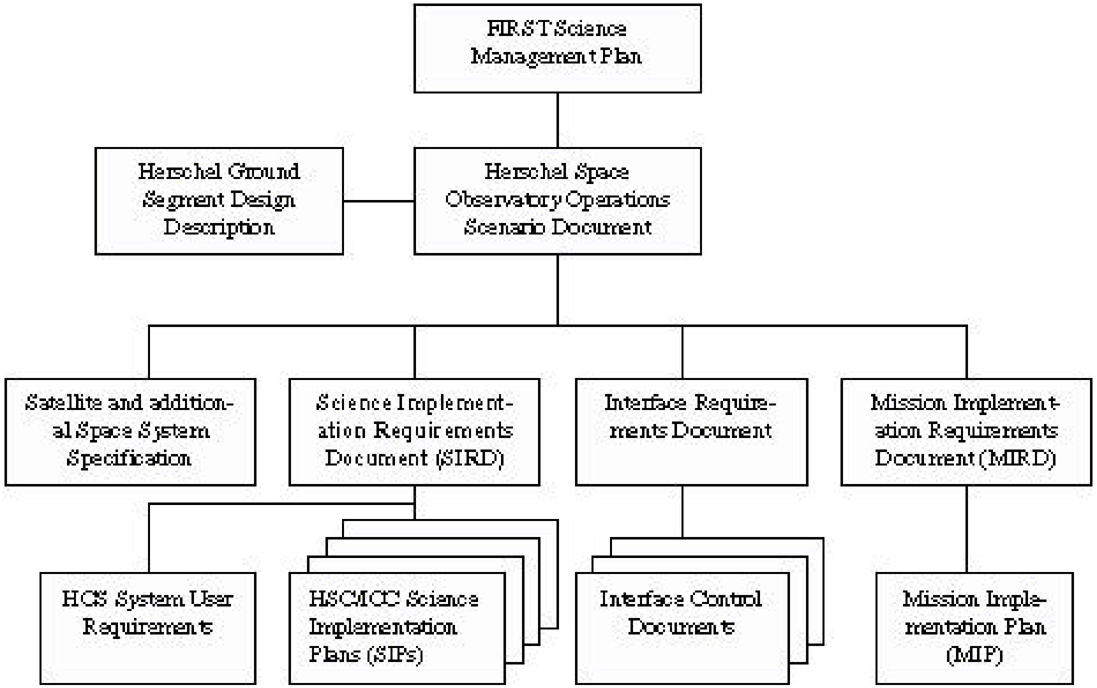
Context

- **The ICC Development Plan is called the Science Implementation Plan (SIP)**
  - **Written in response to the Science Implementation Requirements Document (SIRD)**
    - Derived from Operations Scenario Document
  - **Plus additional requirements, mostly arising from the use of the ICC systems within the consortium:**
    - Use during ILT, including provision of QLA
    - Processing of auxilliary modes
    - Support to consortium members
    - Support for consortium to support the ICC!!
    - Publicity and Outreach
    - Support for local astronomers?
  - **These are detailed in the ICC URD(s)**

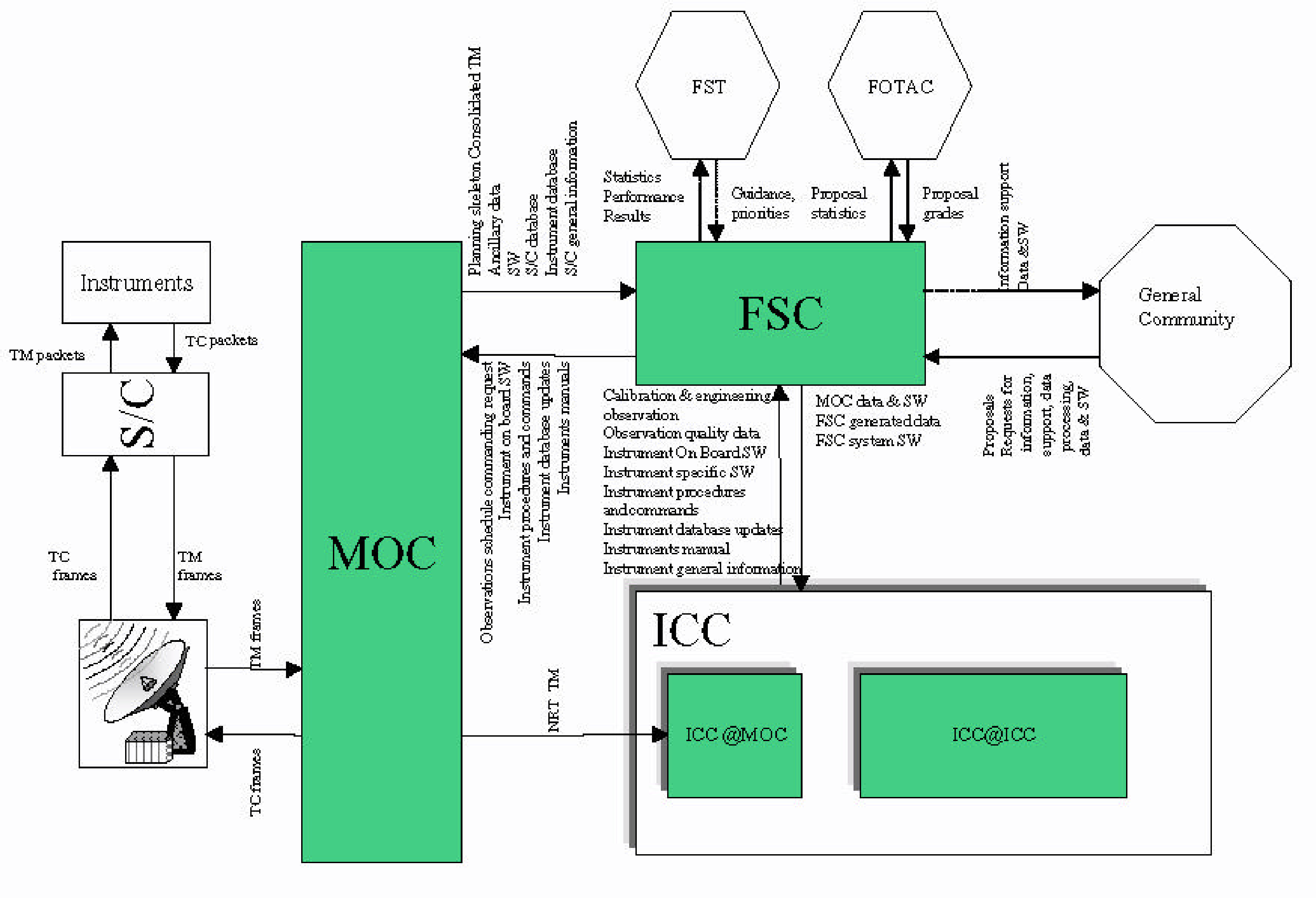
Context cont.

- **The ICC has to fit into the Operational Scenario, which provides for smooth transition between mission phases**
- **It covers all phases of the mission**
  - **Development**
  - **Commissioning and Performance verification**
  - **Routine Operations**
  - **Post Operations**
  - **Archive**
- **A core set of functionality and services has been identified which is being developed as a joint effort between HSC and ICCs. This is called the Herschel Common Science System (HCSS).**

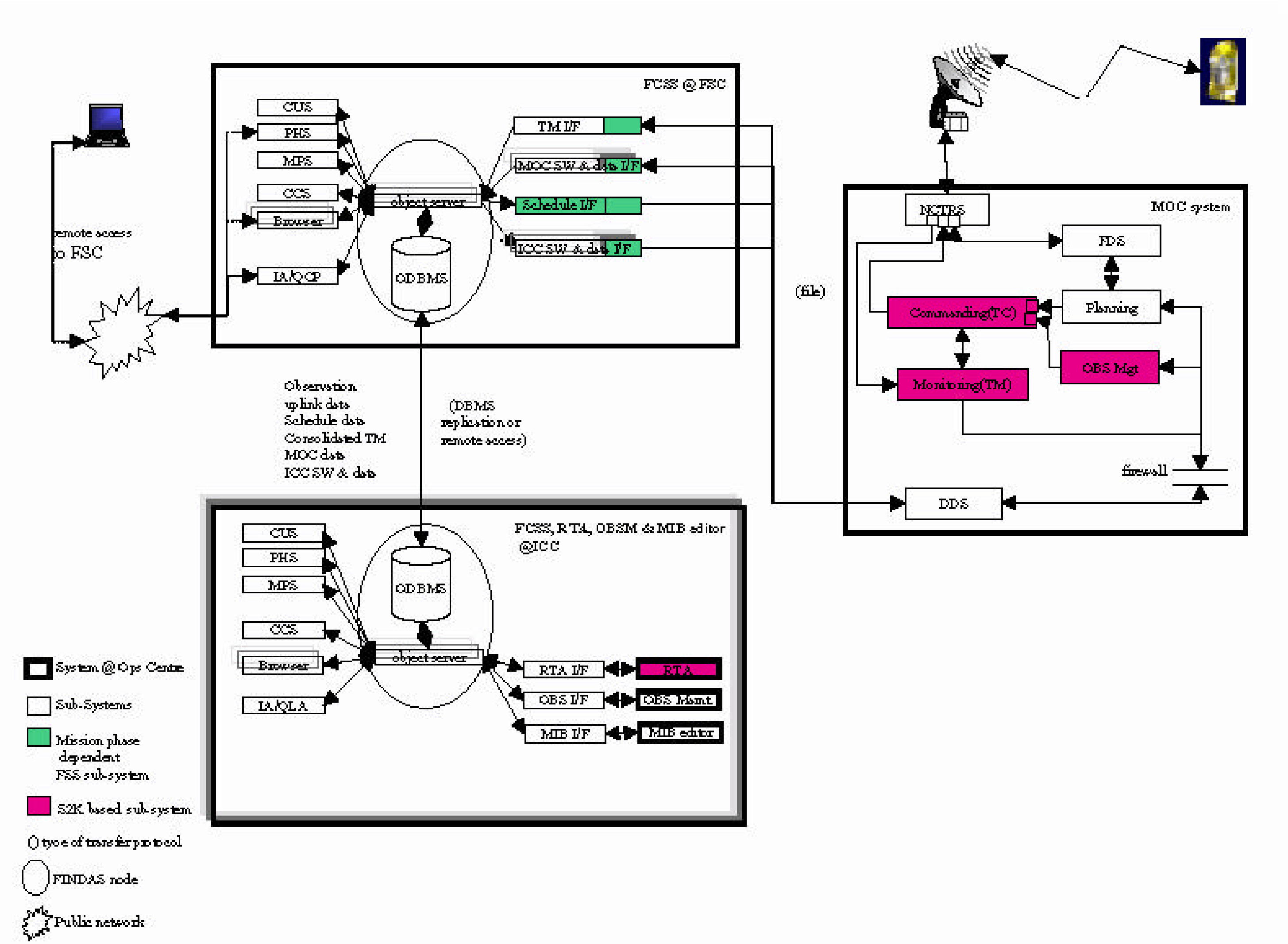
Ground Segment Documentation Tree



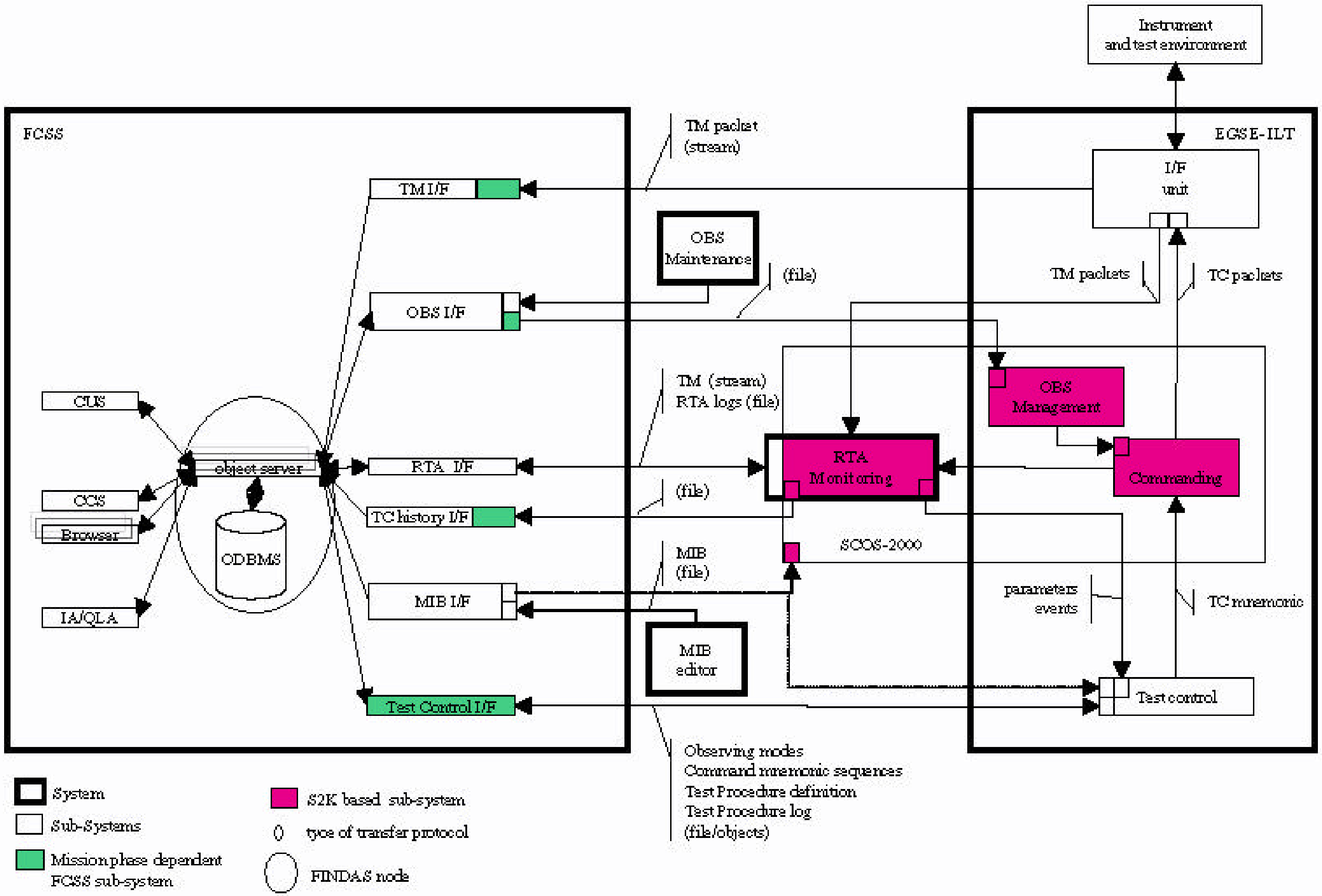
Ground Segment Overview



Ground Segment during Routine Operations



HCSS use during ILT



Ground Segment Development Schedule

(1)	SIP 1st Issue	31st May 2001	Delayed
(2)	SIP Review	25th June 2001	Delayed (to Sept?)
(3)	HCSS v0.1 Delivery	Apr 2002	
(4)	**Ground Segment Requirements Review**	**Feb 2003**	**(L-4 years)**
(5)	**Ground Segment Design Review**	**Feb 2004**	**(L-3 years)**
(6)	SVT-0	Aug 2005	(L-18 months)
(7)	**Ground Segment Implementation Review**	**Feb 2006**	**(L-1 year)**
(8)	SVT-1	April 2006	(L-10 months)
(9)	SVT-2	Aug 2006	(L-6 months)
(10)	**GroundSegment Readiness Review**	**Oct 2006**	**(L-4 months)**
(11)	Operations Readiness Review	15th Jan 2007	(L-1 month)
(12)	Launch	15th Feb 2007	(L)
(13)	Mission Commissioning Review	May 2007	(L+3 months)

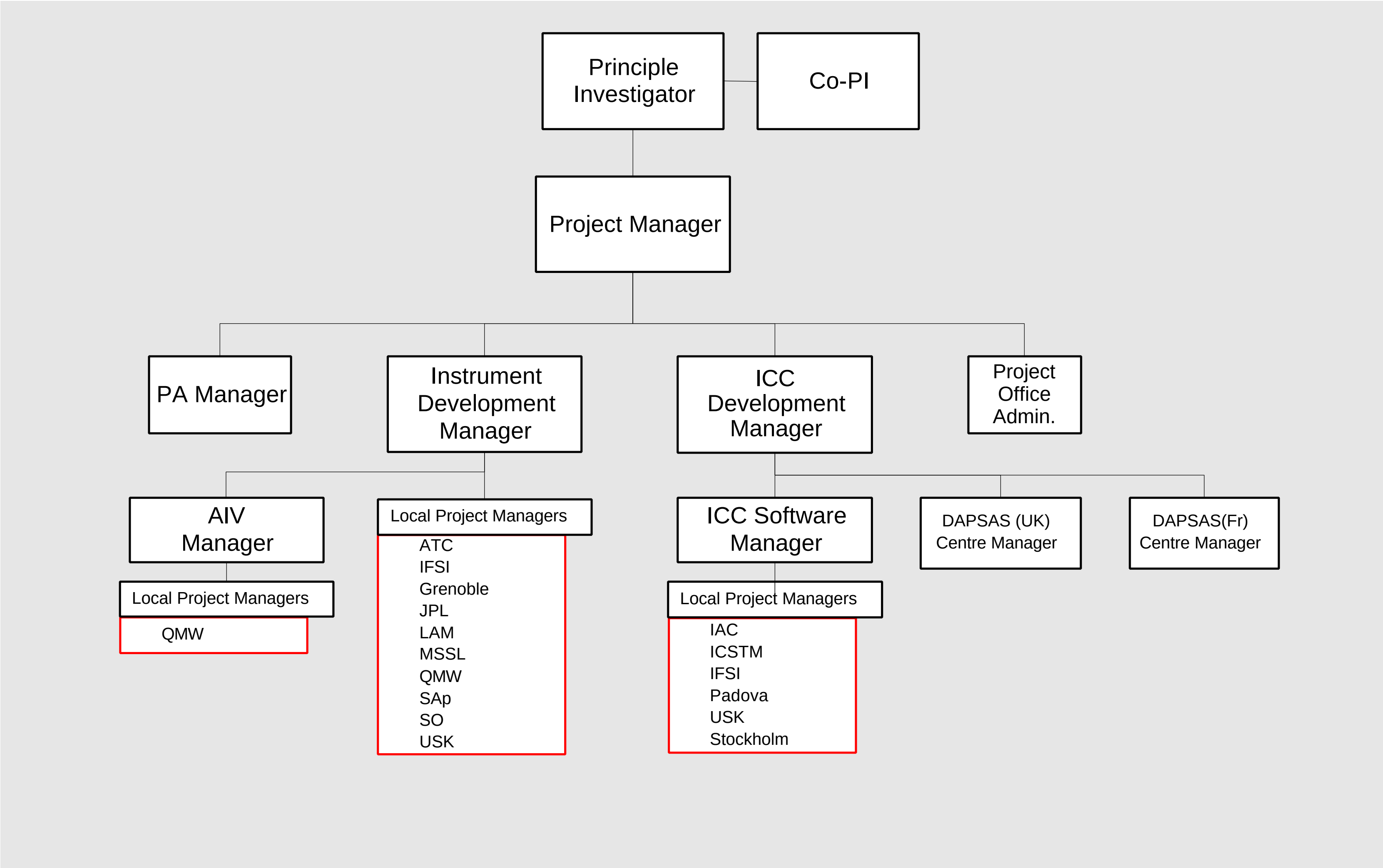
Immediate ICC Schedule

- **Work Definition (July-Sept):**
  - **Consolidation of URDs and Summary-level Use cases**
    - including correlation matrices
  - **Identification and costing of Workpackages**
    - development of some User-level Use cases
    - including correlation matrix
  - **Milestones:**
    - Requirements Review, Aug
    - WP Assignment meeting, Sept
    - SIP Delivery Sept
- **Work Definition (Sept-):**
  - **Definition of User-level Use cases and domain model**

SPIRE Contributions to HCSS

- **HCSS System Engineering**
  - **Integration and Test**
- **HCSS Version 0.1 (due April 2002)**
  - **Out-of Limits Ingestion into HCSS**
    - Code plus ICD
  - **TC history Ingestion into HCSS**
    - Code plus ICD
  - **TM / Data Frame delivery from HCSS to clients**
    - Code plus ICD
  - **SPIRE Data Frame Generator**
    - Internal to HCSS
  - **IA/QLA Framework**
    - a contribution
- **HCSS for Instrument-Level Tests (initial version Dec 2002)**
  - **SPIRE QLA Routines**

SPIRE Management Structure



ICC Development Teams

- **ICC Definition Team**
  - **responsible for:**
    - defining the ‘requirements’ on the ICC
    - identifying and costing WPs as input to Steering Committee
  - **members**
    - ICC Scientist **(Seb Oliver)**
    - Centre managers (Ken King, Marc Sauvage, Matt Fox)
    - Project scientists (Jean-Paul Baluteau, Walter Gear)
    - other interested parties (Matthew Graham, Steve Guest, Tanya Lim, Christophe Morriset, Mat Page, Sunil Sidher, Jason Stevens, Gillian Wright)

ICC Development Teams cont.

- **ICC Software Development Team**
  - **responsible for implementation and test of the software**
  - **members**
    - ICC Software Manager (Steve Guest)
    - Matt Fox, Matthew Graham, Sunil Sidher, TBD Italian

- **ICC Management Team**
  - **responsible for implementation of the ICC**
  - **takes over after assignment of WPs by steering committee**
  - **includes**
    - ICC Development Manager (Ken King)
    - DAPSAS (UK and Fr) Centre managers (Matt Fox, Marc Sauvage)

ICC Development Workpackages

Code	Description	Start Date	Due Date	W.P Manager
GHS1	**ICC Development**			
GHS11	**Management**			
GHS11x1000	ICC Management			
GHS11x2000	Support to Ground Segment Development			
GHS11x3000	System Engineering			
GHS11x4000	Product/Quality Assurance			
GHS12	**Instrument Operations**			
GHS12x1000	Provision of Instrument Users Manual			
GHS12x2000	Provision of Instrument Database			
GHS12x3000	Provision of Calibration Database			
GHS12x4000	Definition of Instrument Observations			
GHS12x5000	Definition of Operating Procedures			
GHS12x6000	Provision of Observers Manual			
GHS13	**Software Development**			
GHS13x1000	SPIRE contribution to HCSS			
GHS13x2000	Software Infrastructure			
GHS13x3000	Quicklook Analysis			
GHS13x4000	Interactive Analysis			
GHS13x5000	Calibration Analysis			
GHS13x6000	Trend Analysis			
GHS23x7000	Diagnostic tools			
GHS23x8000	Instrument Simulator			
GHS14	**ILT Support**			
GHS14x1000	Provision of ILT System(s)			
GHS14x2000	Support to ILT Tests			
GHS15	**Miscellaneous**			
GHS15x1000	Support to Consortium			

ICC OPS Preparation Workpackages

Code	Description	Start Date	Due Date	W.P Manager
GHS2	**ICC Operations Preparation**			
GHS21	**Facilities**			
GHS21x1000	ICC Operations Centre			
GHS21x2000	DAPSAS (UK) Centre			
GHS21x3000	DAPSAS (Fr) Centre			
GHS21x4000	ICC@MOC			
GHS21x5000	On Board Software Maintenance Facility			
GHS22	**Operations Phase Preparation**			
GHS21x1000	Operations Plan			
GHS21x2000	ICC/HSC Operational Interactions			
GHS21x3000	ICC/MOC Operational Interactions			
GHS21x4000	Operations Team Setup and Training			
GHS23	**Integration and Test**			
GHS23x1000	ICC Integration			
GHS23x2000	Ground Segment Integration			
GHS23x3000	Ground Segment Testing			
GHS24	**Commissioning Phase**			
GHS24x1000	Commissioning Phase Support			

ICC Operations Workpackages

Code	Description	Start Date	Due Date	W.P Manager
GHS3	**ICC Operations**			
GHS31	**Management**			
GHS31x1000	Operations Management			
GHS31x2000	Product/Quality Assurance			
GHS32	**Software Maintenance**			
GHS32x1000	SPIRE contribution to HCSS maintenance			
GHS32x2000	IA Evolution			
GHS32x3000	IA Maintenance			
GHS32x4000	OBS maintenance			
GHS32x5000	ICC software maintenance			
GHS33	**Operations**			
GHS33x1000	Health and Status Monitoring			
GHS33x2000	Performance Monitoring and Diagnostics			
GHS33x3000	Calibration			
GHS33x4000	Trend Analysis			
GHS33x5000	Science Quality Checking			
GHS33x6000	Performance Maintenance			
GHS33x7000	Ground Segment Interactions			
GHS33x8000	Parallel Mode Analysis			
GHS33x9000	Serendipity Mode Analysis			
GHS33xA000	Support to MOC			
GHS33xB000	Support to HSC			
GHS33xC000	Support to Community			
GHS33xD000	Consortium Support to the ICC			
GHS34	**Facilities Maintenance**			
GHS34x2000	System Maintenence			
GHS34x1000	System Management			

SPIRE Herschel Observing Time

- The Herschel Science Management Plan
- The amount of Guaranteed Time available to us
- Key Programmes
- HST views on Key Programmes and GT
- Questions for the SPIRE Consortium

SPIRE

The Herschel Science Management Plan

- **The SMP describes the policies for organisation of Herschel science operations, data processing and data rights**
- **Approved by the ESA Science Policy Committee (SPC) in 1997**
- **It was part of the AO documentation**
- **Available at http://astro.esa.int/FIRST**
- **Herschel is an Observatory mission**

SPIRE

Herschel Observing Time

- **Minimum operational lifetime is 3 years » 1100 days**
- **Daily communication period with Perth ground station: 3 hrs or less (assume 3 hrs) with restricted pointing (assume no science during this period)**
- **Total observing time » 23,000 hours**
- **Allow for technical operations etc.:**
  ® 21,000 hrs (~ 7,000 hrs/year)
- **All observing proposals to be assessed by the *Herschel Science Centre* (HSC) for technical feasibility and by the *Herschel Observing Time Allocation Committee* (HOTAC) for scientific merit**

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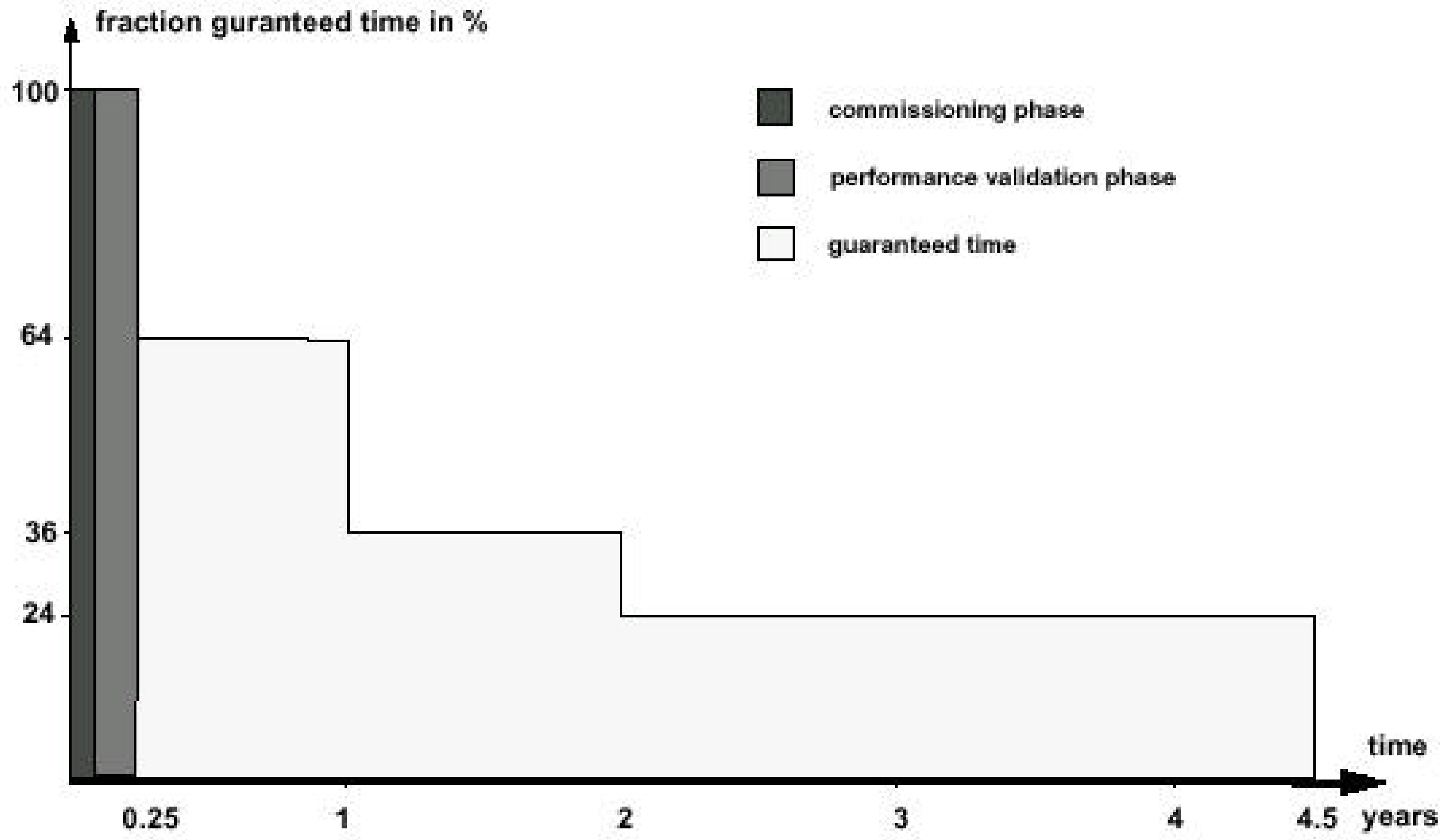
Herschel Observing Time

- **Open Time (OT): 68% » 5,200 hrs/year**
  - Most available to world-wide scientific community (including GT holders) through competitive proposals
  - Targets of opportunity
  - Discretionary time (max. 4%), including 'serendipitous' ToOs
- **Guaranteed Time (GT): 32% » 2,500 hrs/year**
- **GT is divided between**
  - Three instrument teams: 30% each » 740 hrs/year each
  - Herschel Science Centre 7% » 170 hrs/year
  - Mission Scientists 3% » 75 hrs/year
- **So SPIRE GT » 2,200 hrs (around 100 days)**

SPIRE

GT Fraction during the Mission

- **GT is envisaged to occupy greater share of the time in the early part of the mission**



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Key Projects

- **SMP anticipates that Key Projects in the form of large surveys will form a significant part of the observing programme**
- **Project Scientist and Herschel Science Team are responsible for devising strategy and procedure for implementing Key Projects while optimising the overall efficiency of the mission**
- **Key Programmes envisaged to be done early in the mission**
  - **Ensures core science done in case of misfortune**
  - **Allows for follow-up observations**
- ***"Guaranteed time holders will be required to devote the major fraction (i.e. 50%) of their time to these key projects".***
- ***"It will then be natural that international key project consortia are forming, including both guaranteed and open-time holders, with data rights according to the time provided for the project."***
- ***"The leaders of these key project consortia will be responsible for the coordination of these programs; such a leader can be either a guaranteed or open time holder."***

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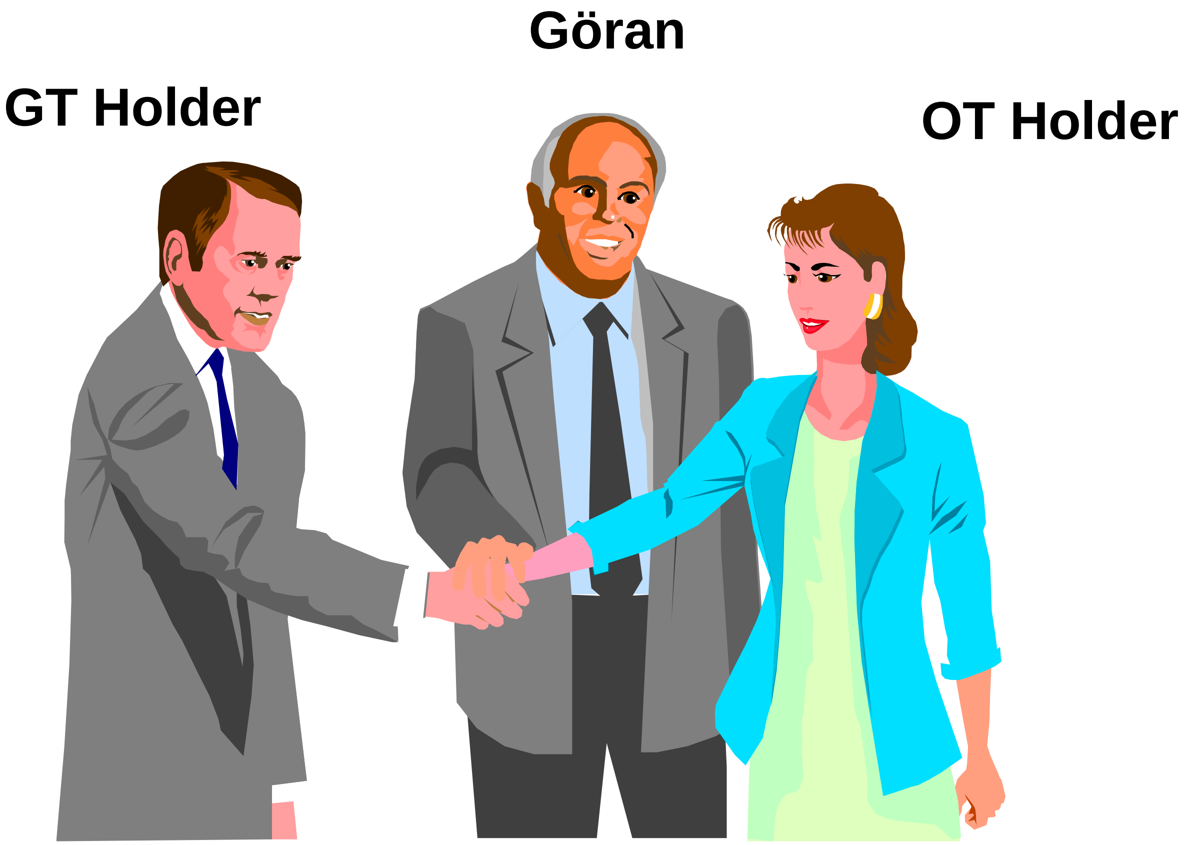
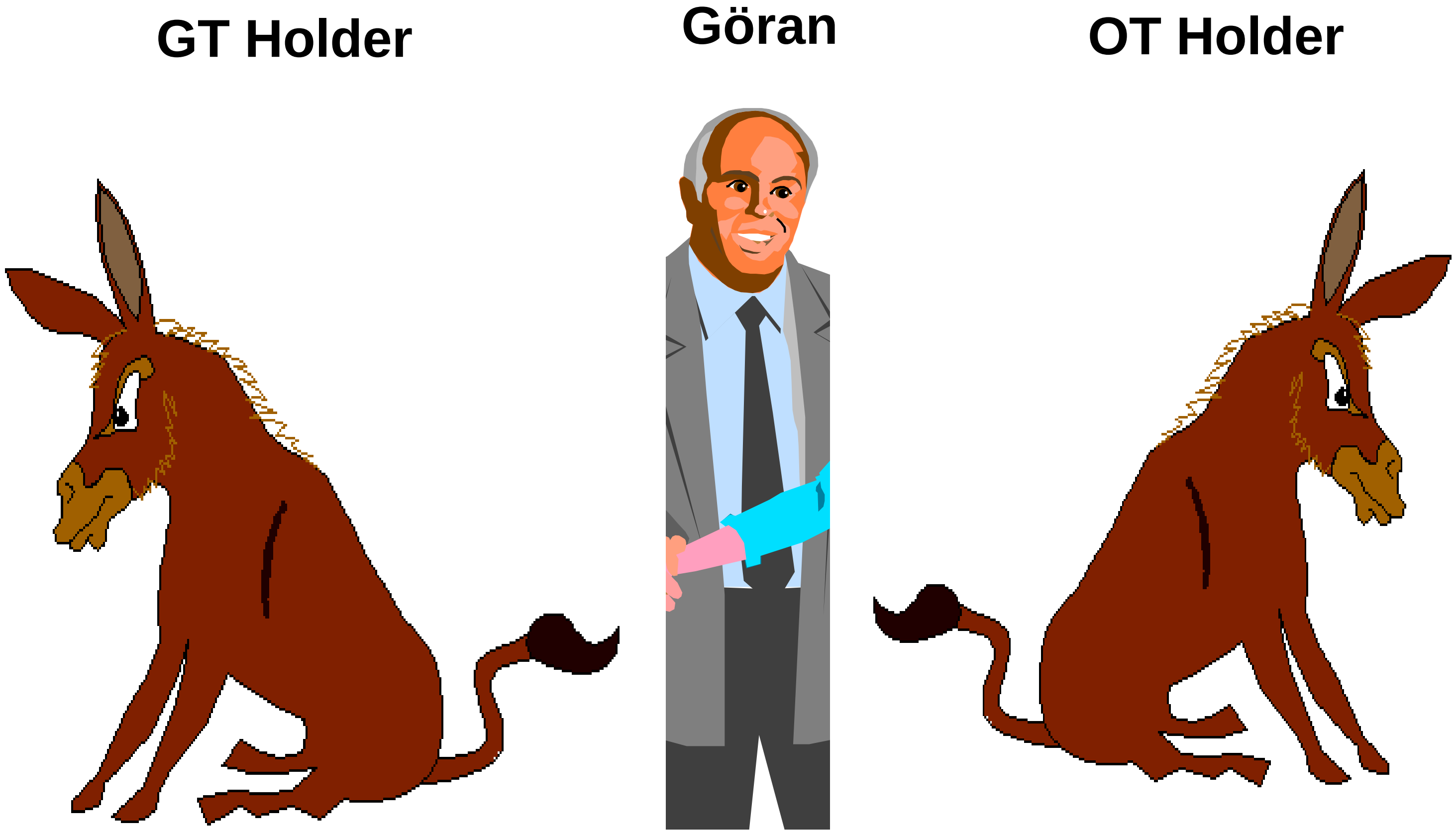
Key Projects – How it Should Work



Key Projects – How it Might Turn Out



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Key Projects

- The SMP envisages early call for Key Projects with call for normal projects issued after Key Projects are defined
- At least one call for OT proposals is planned after release of survey data

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Proprietary Period

- Data will become public when 1 year has elapsed since scientifically validated data have been available to the observer

- Data will be scientifically validated:

  - 2 years after successful completion of PV phase, for observations performed in the first year after successful completion of PV

  - 1 year after the date of observation, for observations performed more than one year after successful completion of the PV phase and for all "survey" observations.

- The data release policy applies to each sub-observation separately

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Data Products Strategy

- Enable observer to generate products with best available means (software)
- "Enable" is the responsibility of the Herschel Science Centre
- "Best available means" (software, IA, etc) is the responsibility of the instrument teams (ICCs)
- Final archive in post-operational phase will use 'final' products and 'final' best means

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HST Deliberations

- The SMP is the starting point – any significant departure must go through AWG - SSAC - SPC approval cycle
- HST and ESA now see some merit in the ICCs processing the data from the early part of the mission (good idea but significant resources needed for this . . .)
- HST has considered an alternative approach to adhere to the spirit of the SMP
    - First ~ 1 year of routine operation used for Key Projects (spatial and spectral surveys): Archive Building Phase
    - This is "Herschel time" – not GT or OT
    - Initial catalogues released to community very soon afterwards allowing unrestricted access for follow-up proposals

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HST Deliberations

- The remaining two years or more of the mission divided into GT and OT according to the formula in the SMP
- HOTAC should give strong encouragement to GT and OT proposers to construct large, coherent, well-planned programmes
- Advantages of the "Archive Building" scheme:
  - Gets around the complex and messy problem of marrying GT and OT holders
  - Early, well-organised, implementation of core science of the mission with maximum chance of good follow-up
- Questions/Challenges:
  - Who decides on survey strategy (fields, observing strategy etc.) and by what proposal/assessment process?
  - How to incorporate rights and interests of GT holders to survey data (head start?)
  - Additional resources needed by the ICCs need to process the data and produce catalogues for early release?

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Questions for us

- Do we approve of the "Archive Building" scheme?
  - Will it protect us from being swamped by the community?
  - Will it protect the community from being shut out by us?
    - creaming off the best science with our GT;
    - blocking sources and observations.

- In ANY scenario, our GT will not be enough to do all that we want (especially surveys). So,
  - How do we prioritise between scientific areas?
  - How do we approach GT programme definition?
    - Many small programmes vs. few big ones
    - Integrated Herschel science vs. dedicated SPIRE science
    - Collaborations with other GT holders (PACS, HIFI, MS teams, HSC) or go-it-alone?

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Questions for us

- **How do we balance the national contributions to SPIRE in terms of scientific return?**

- **How do we protect the scientific interests of instrumentalists who work on H/W and testing for long periods up to launch?**

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Some Thoughts

- Herschel is a very expensive mission
  - Efficient use of the helium for the long-term benefit of the community is <u>paramount</u>
- We cannot do everything
- We are (currently) expected to collaborate with the community
- We should expect to have a prominent role in programmes for which our expertise will be vital
- Decisions on use of SPIRE GT depend on two things
  - Constraints within which we operate
  - Our own scientific priorities
- The Archive-building concept can only work if:
  - It is properly resourced – who pays?
  - There is a reasonable period in which to generate the catalogues (but must be early enough for follow-up).
  - There is strong participation by the instrument teams in defining the observing programme.

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Conclusion

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Aims of the splinters

- **Establish some guidelines for future work and discussion**
- **Get a first picture of**
  - **Where our scientific priorities lie**
  - **Whether we prefer to collaborate with others or go it alone**
  - **Whether we prefer many small programmes or few big ones**
- **Avoid constructing a detailed programme now**
- **Consider the science that we want to do with Herschel (not just SPIRE)**

SPIRE

Baseline

- The Science Management Plan is the baseline:
  - GT done mainly early in the mission
  - We're expected to collaborate with OT holders on Key Projects (with at least 50% of our GT)
  - We should plan for this until otherwise instructed

Questions

- What elements of Herschel science do we want to do? (it can't be everything . . .)

- For the 50% of GT over which we have more control, should we copllaborate with others or establish independent programmes?

- The "Archive Building" scenario is just a concept that is being discussed . . .
  - What would the implications be if it were adopted?

Deep Surveys with SPIRE and Cosmology

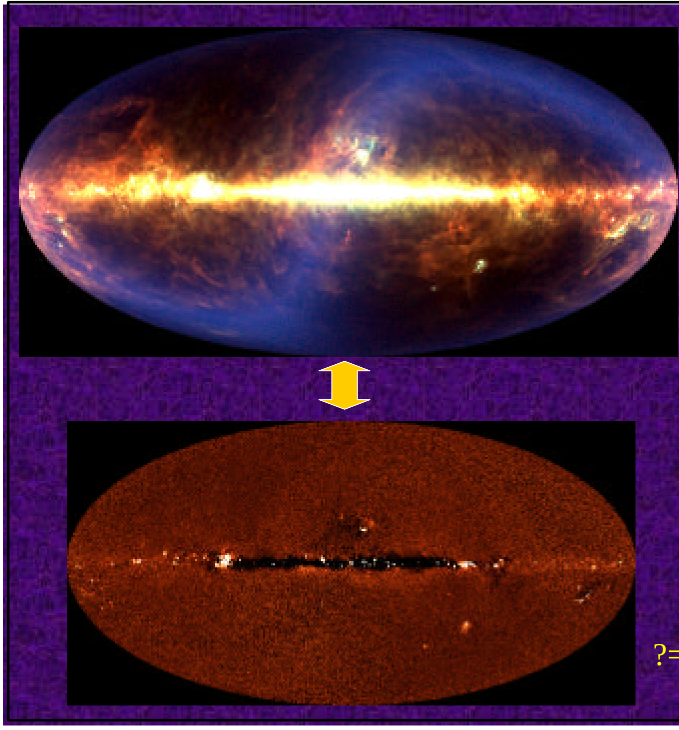
A. Franceschini
Padova University

SPIRE Consortium Meeting

Cardiff, July 4 - 6

Summary

- A review of recent facts:
  - ✓ The Background Radiation: new discoveries
  - ✓ Observations with millimetric telescopes
  - ✓ IR observations with space observatories
- Main open problems to be addressed by the Herschel cosmological surveys:
  - ✓ Formation of galaxies
  - ✓ Formation of quasars and AGNs
  - ✓ Relevance of long-λ observations: are they needed ?
- Survey strategy: some comments
- Herschel cosmological surveys in the context: what is unique compared to the variety of planned space and ground experiments

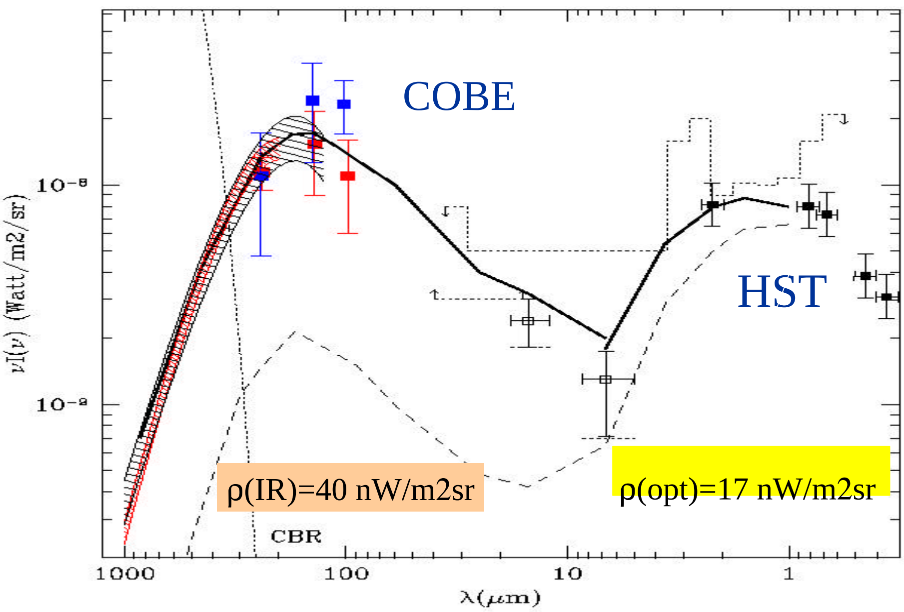


COBE

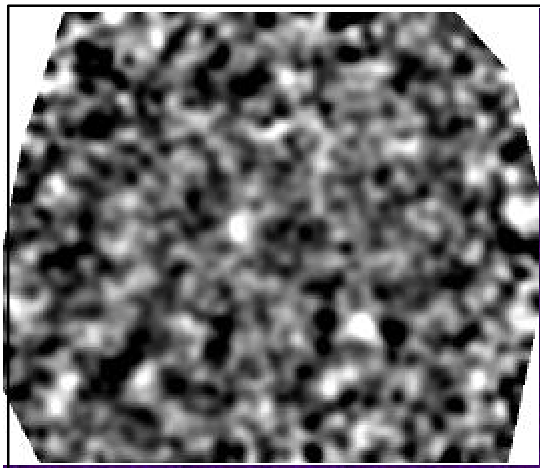
Discovery of the
Cosmic Infrared
Background (CIRB)

(Puget et al. 1996;
Hauser et al. 1998)

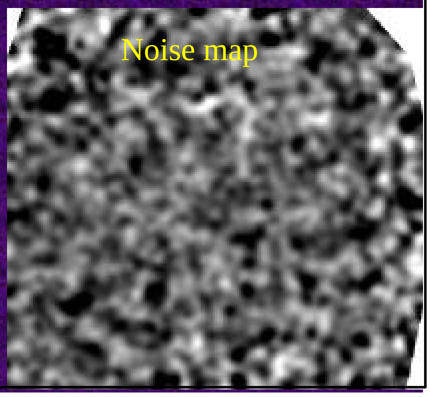
?=100 µ



The Infrared and Optical Background Radiations



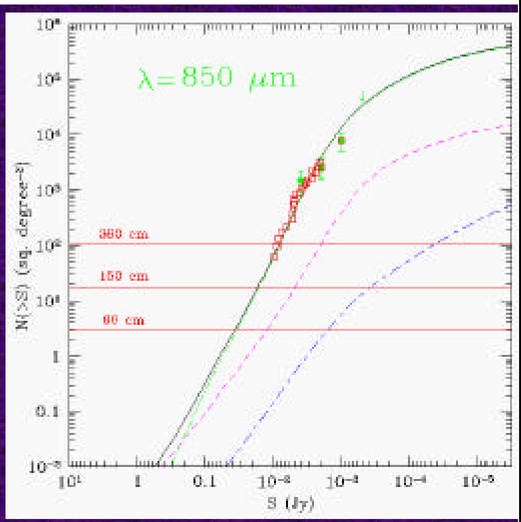
6.9x6.4 arcmin
19 sources above 3.5 mJy



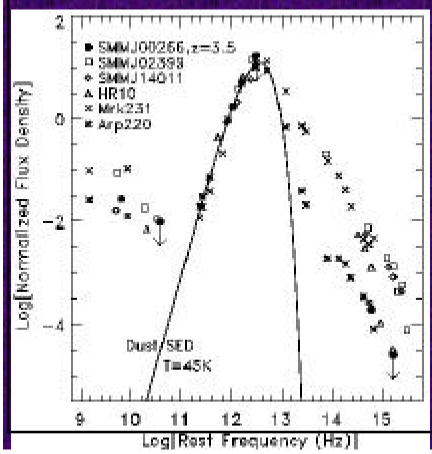
SCUBA 850 μ survey of the CFRS 1415h field

(Eales et al. 2000)

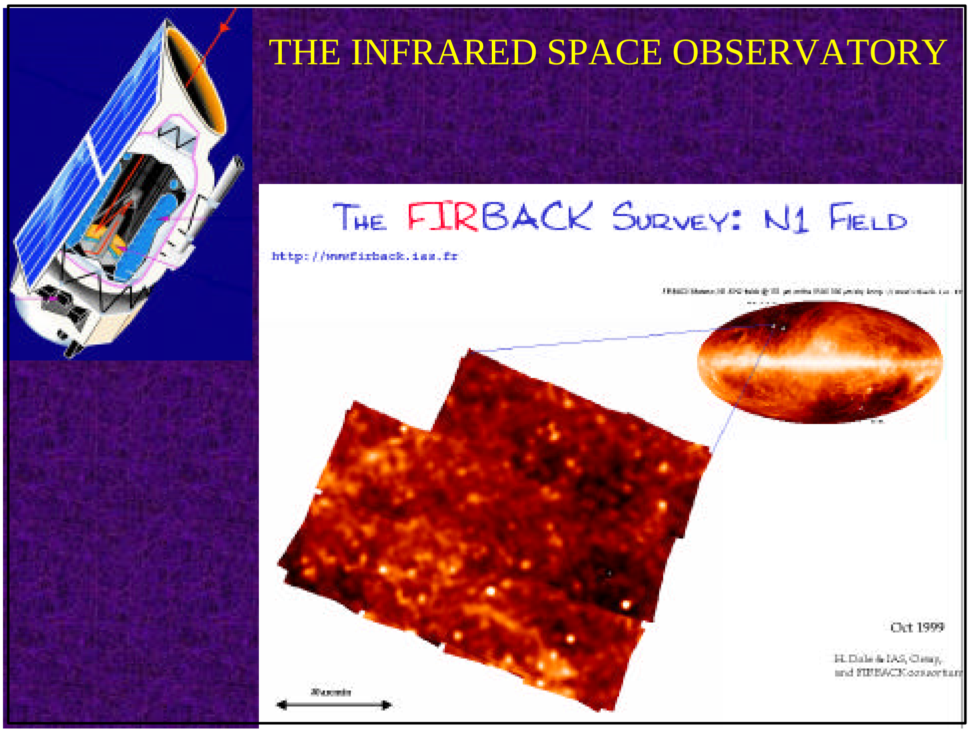
Integral counts at 850 μ

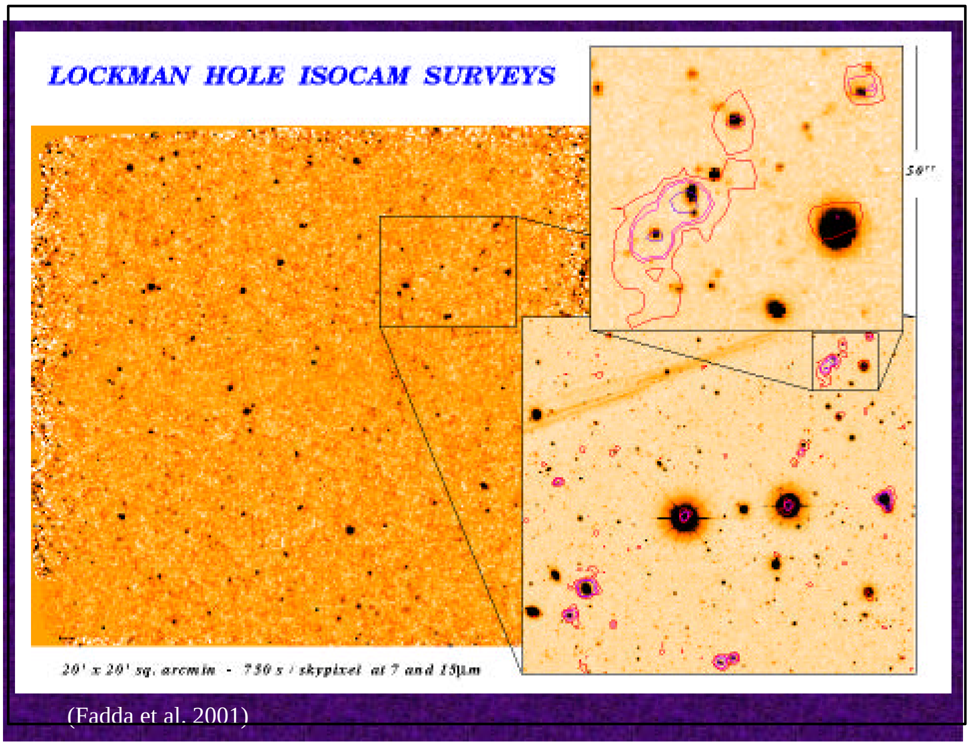


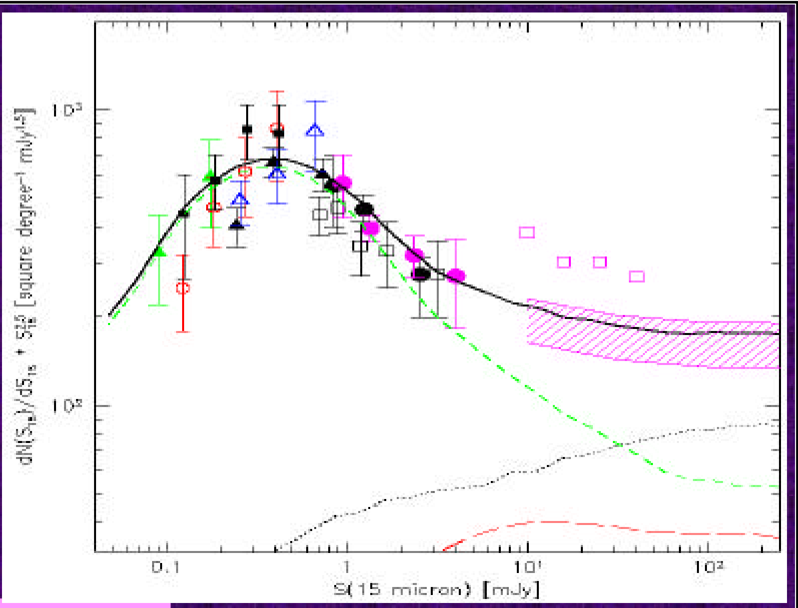
(Franceschini et al. 2001)



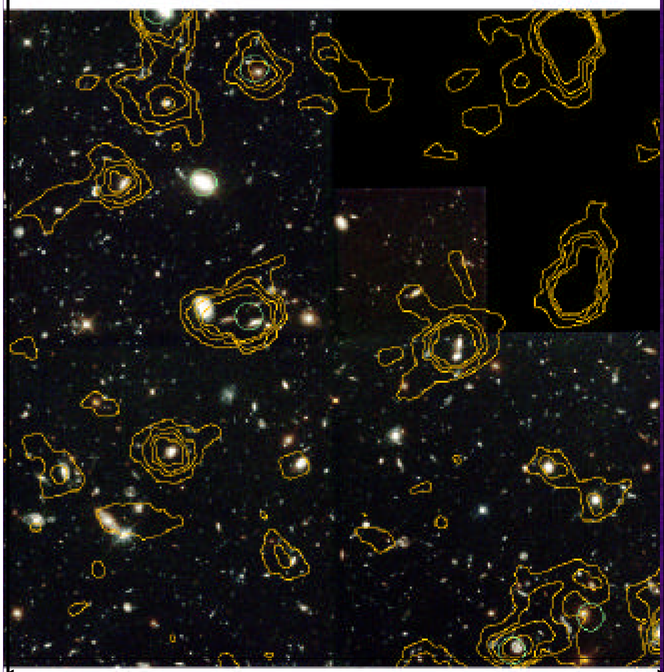
Ultraluminous sources at high z


THE INFRARED SPACE OBSERVATORY
THE FIRBACK SURVEY: N1 FIELD
Oct 1999

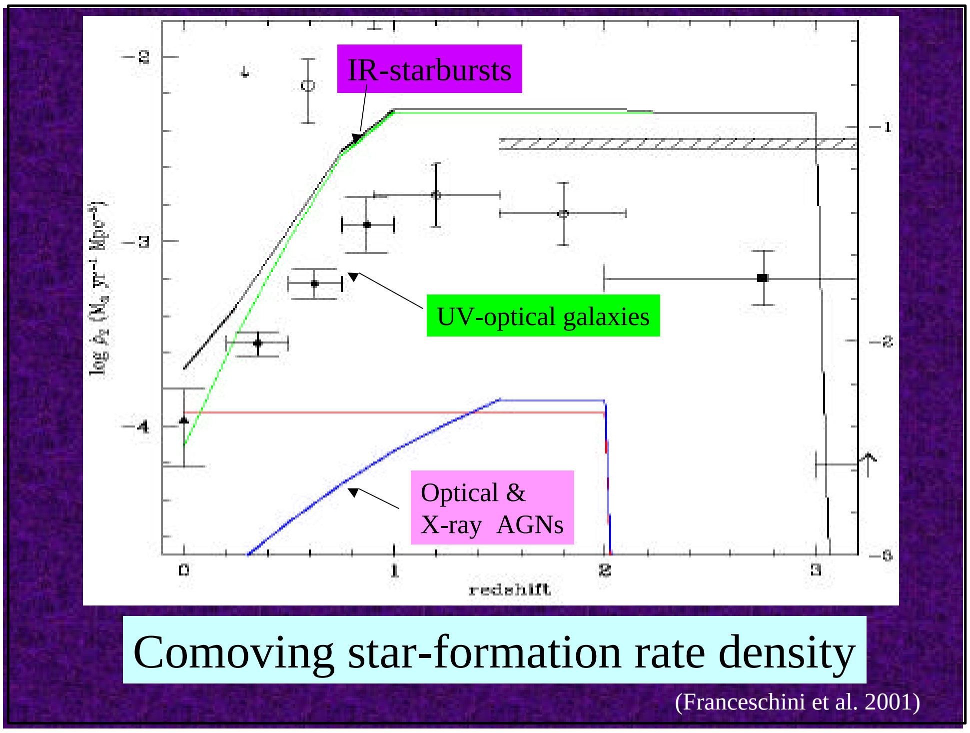

LOCKMAN HOLE ISOCAM SURVEYS
20' x 20' sq. arcmin - 750 s / skypixel at 7 and 15μm
(Fadda et al. 2001)

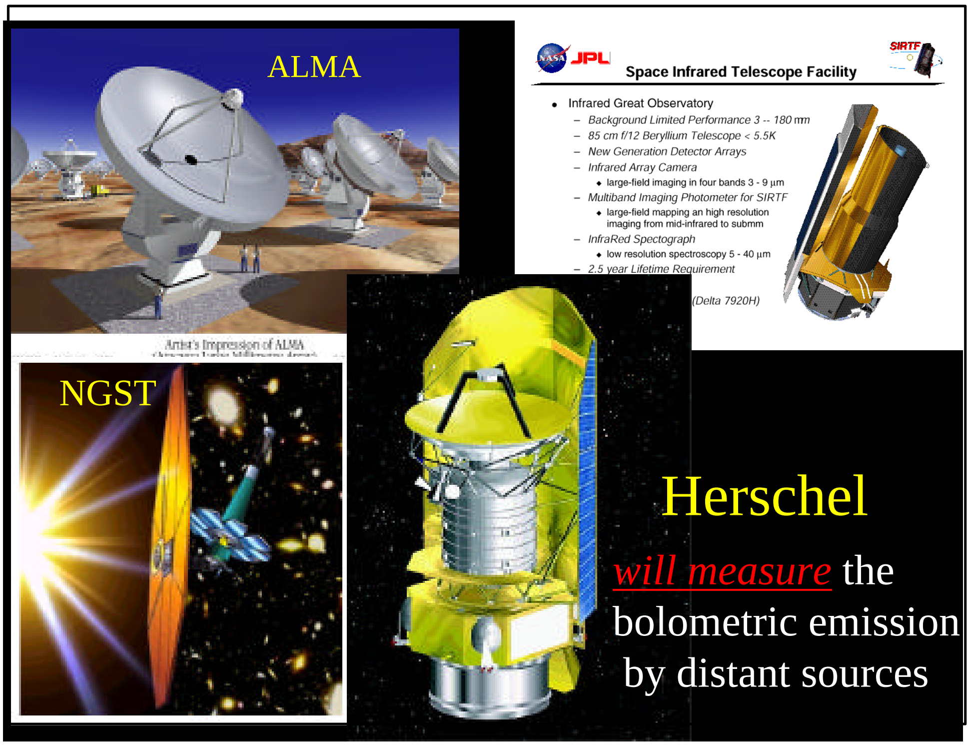


15 µ differential counts
(Euclidean normalized)
[Elbaz et al. 1999]



HDF-North image overlayed by the ISOCAM LW3 15 µ contours by Aussel et al. 1999


IR-starbursts
UV-optical galaxies
Optical &
X-ray AGNs
redshift
Comoving star-formation rate density
(Franceschini et al. 2001)


ALMA
Artist's Impression of ALMA
NGST
JPL
Space Infrared Telescope Facility
SIRTF
Infrared Great Observatory
Background Limited Performance 3 -- 180 mm
85 cm f/12 Beryllium Telescope < 5.5K
New Generation Detector Arrays
Infrared Array Camera
large-field imaging in four bands 3 - 9 µm
Multiband Imaging Photometer for SIRTF
large-field mapping an high resolution imaging from mid-infrared to submm
InfraRed Spectograph
low resolution spectroscopy 5 - 40 µm
2.5 year Lifetime Requirement
(Delta 7920H)
Herschel
will measure the
bolometric emission
by distant sources

OPEN ISSUES TO BE ADDRESSED BY THE Herschel COSMOLOGICAL SURVEYS

•BASICALLY, THEY WILL ALLOW TO ***MEASURE*** THE BOLOMETRIC EMISSION BY DISTANT GALAXIES IN A COMPLETELY UNBIASSED WAY

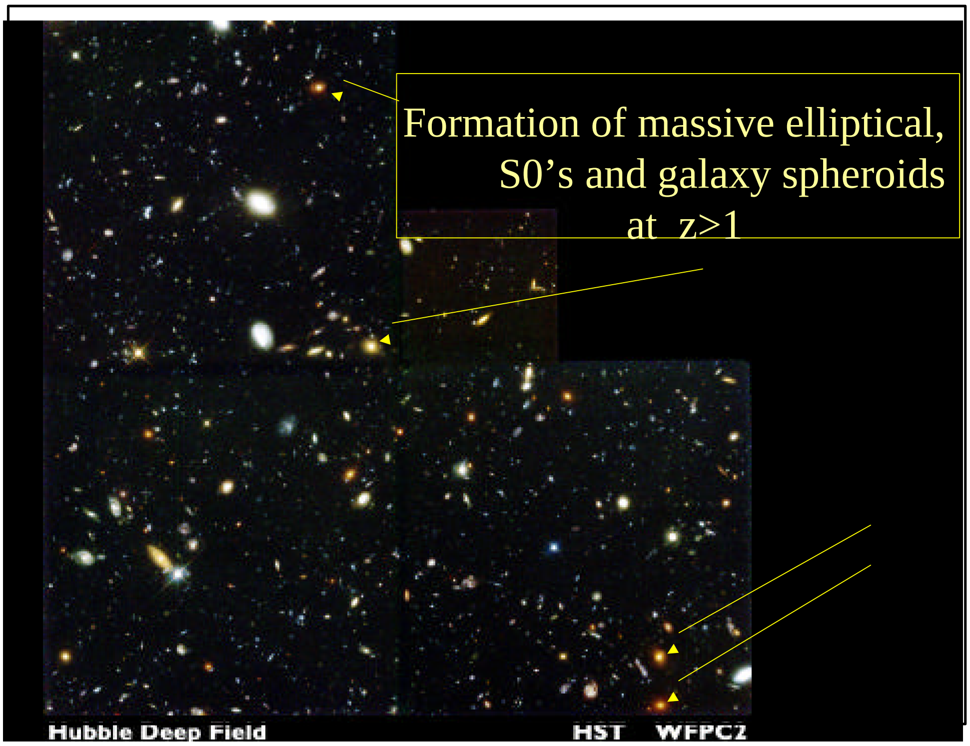
↓

- **NATURE OF THE IR EMISSION BY FAINT IR SOURCES AND ORIGIN OF THE CIRB: STARBURSTS OR AGNs ?**

- **ORIGIN OF SPHEROIDAL GALAXIES**

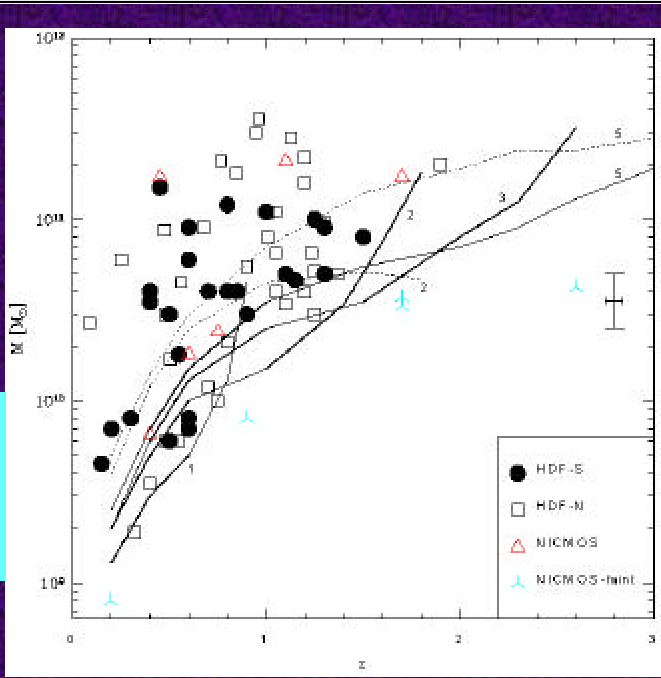
- **THE ONSET OF QUASARS**

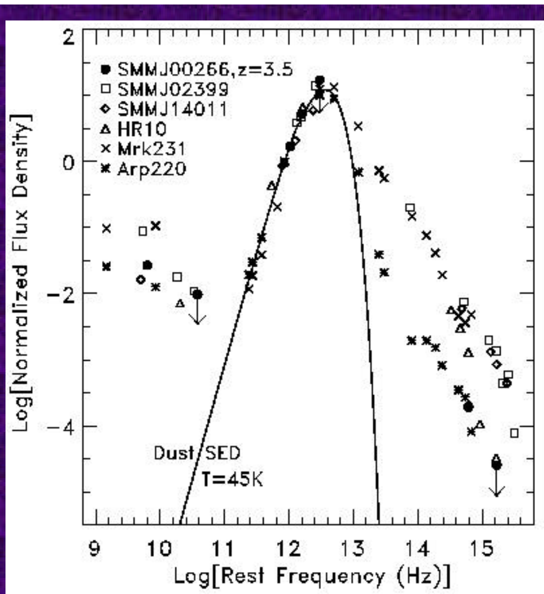
- **HOW MUCH FAR-IR OBSERVATIONS ARE NEEDED TO TRACE THE IR-ACTIVE PHASE ?**



MASSES of E/S0 galaxies in the HDFs vs. redshift

(Rodighiero et al. 2001)

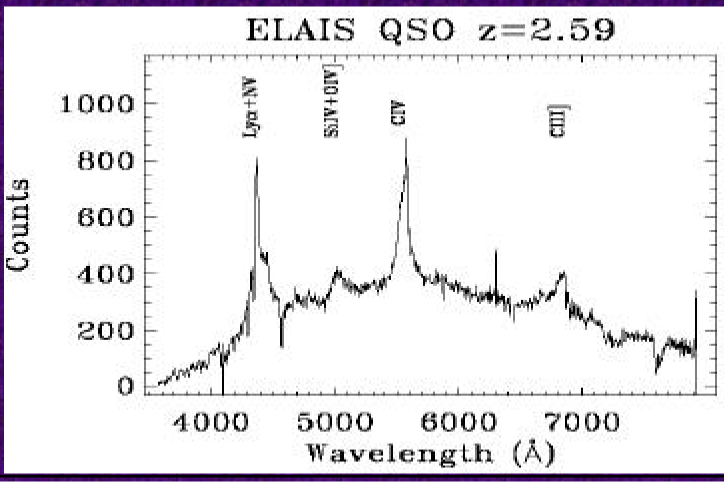




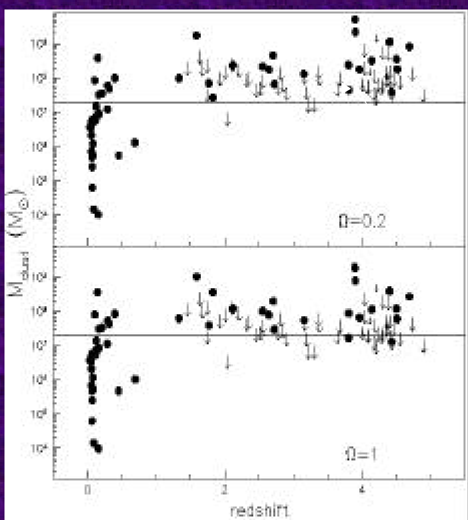
Similarity of SEDs for high-z SCUBA and ISO sources with local LIRGs and ULIRGs

HIGH-REDHIFT QUASARS: EVIDENCE FOR VIOLENT STELLAR FORMATION

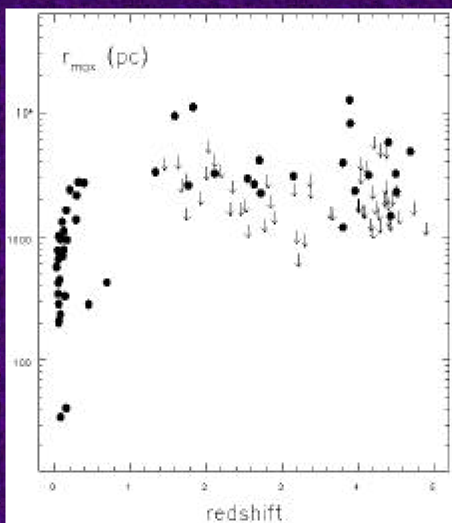
METAL LINES IN HIGH-Z QUASAR SPECTRA: FAST METAL ENRICHMENT AT VERY HIGH REDSHIFTS



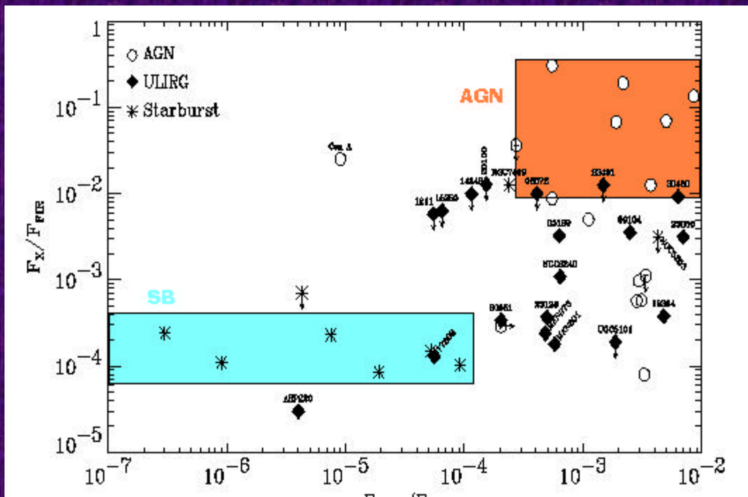
DUST MASSES



EXTENT OF THE DUST DISTRIBUTION



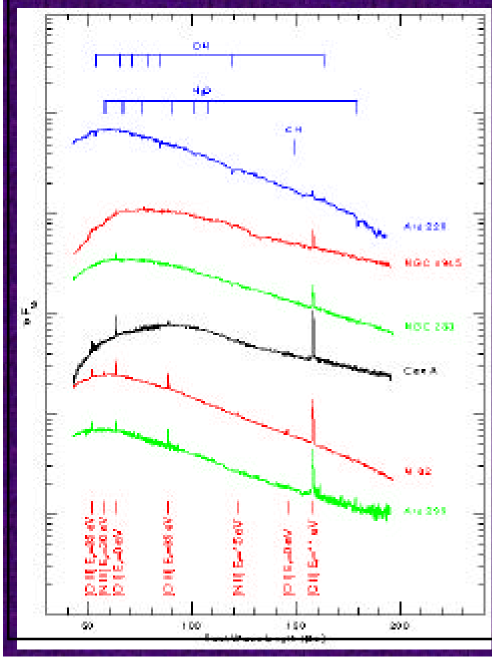
AGN vs. Starburst emission diagnostics

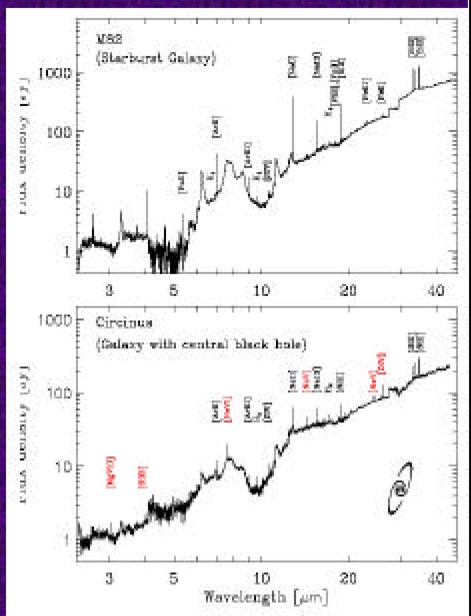


(Bassani et al. 2000)

But, how much reliable is this? Compton-thick AGN emission could not be detected even by hard X-ray observations

Herschel spectroscopy of long-λ ionic lines



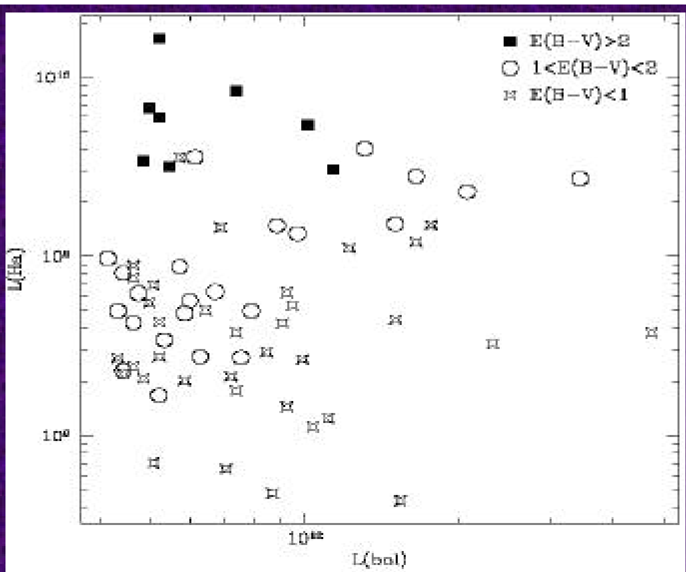


Fischer (2000)

RELEVANCE OF LONG-λ COSMOLOGICAL SURVEYS: ARE THEY NEEDED ?

CAN THE IR-ACTIVE PHASE BE SAMPLED WITH UV-OPTICAL-NIR OBSERVATIONS ONLY ?

How much can be retrived from UV-optical-NIR observations alone without knowledge of the IR emission

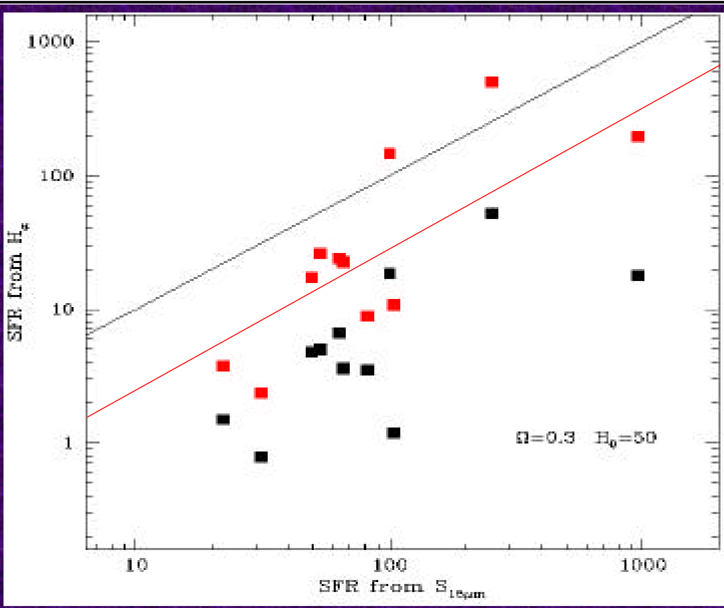


LIRGs and ULIRGs in the Poggianti & Wu sample

→ Poor relation between L(Ha) and L(bol)

SFR from Halpha
uncorrected
and
corrected
for dust-extinction
[based on Balmer
line ratios]

(Rigopoulou et al. 2000)



SFR estimated from the 15 micron flux

Herschel Cosmological Surveys

- Note: general motivation for Herschel identified time ago in the frame of the worldwide effort of modern cosmology to ***Search for the Origins***, involving major future projects (see the NASA dedicated program + new-generation observatories, ALMA, NGST, OWL, SKA,…)

ORIGINS OF →
Large Scale Structure
Galaxies & Quasars
Stellar Populations
Planetary Systems (-> Life)

Herschel as a critical element of this systematic effort for the next 10-20 years

- Can select cosmic sources from their bolometric emission over an extremely wide redshift interval

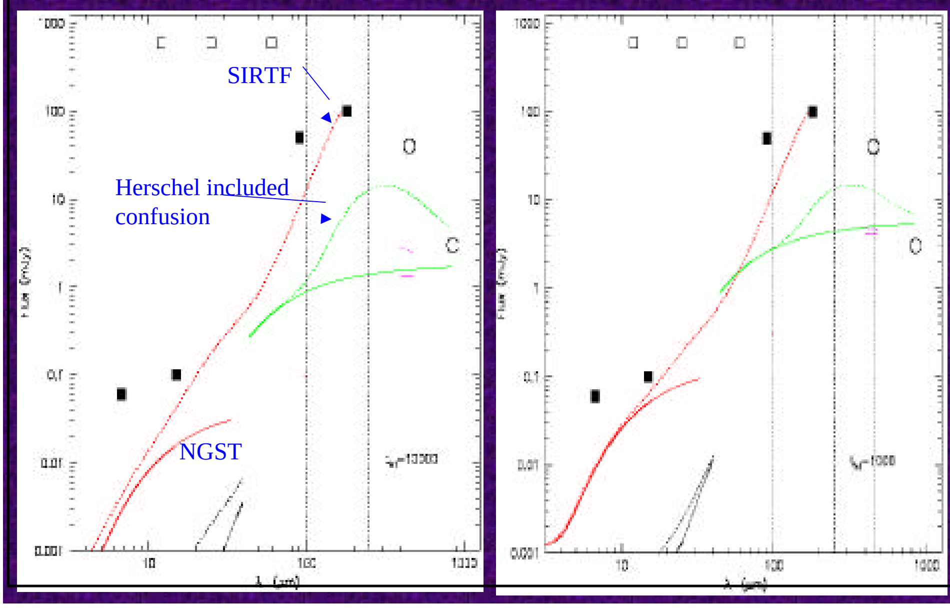
(overcomes the limitations of optical cosmologic surveys, K-correction problem, the limited spectral coverage, samples the ISM)

The most efficient and unbiased way to select the **active phases in galaxy evolution** : surveys between 100 and 300 µm

Although conceived many years ago, Herschel keeps unique features among existing projects to sample the peak of dust emission with enough spatial resolution

Deep surveys over large sky areas among the main motivations of PACS & SPIRE instruments and the mission itself

The Herschel cosmological window



SPIRE SURVEYS

- Essentially 2 surveys strategies discussed in Toledo:
  - **A set of deep surveys (to the confusion limit of ~ 10 mJy), simultaneous in 3 channels at 250, 350, 500 μm, over a total of 50 – 100 gradi quadrati**
    (~ 60 – 120 observation days)
  - **A shallower survey (~ 50 mJy) over a much larger area ~ 1000 square degrees**
    (would cost ~ 5 months of observation?)
- The prospect of the deep surveys to be undertaken by PLANCK with a sensitivity limit of **~100 mJy** at **350** and **550 μm** may indicate the second as a lower priority task

Confusion effects due to extragalactic sources: SCUBA 850 μm Survey

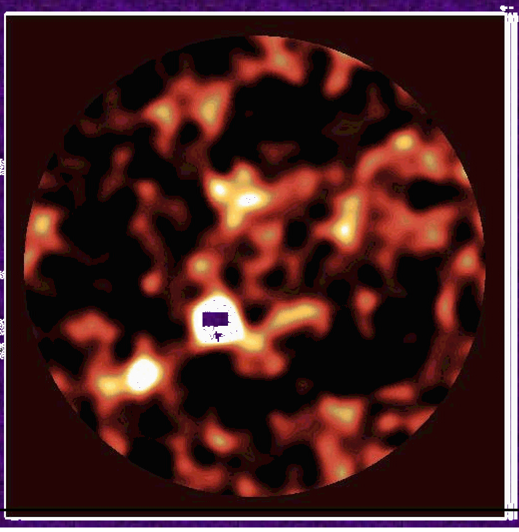
Classical 5σ confusion limit
0.43 sources arc min^{-2}

Area = 8.7 arc min^2

5σ limit 3.8 sources

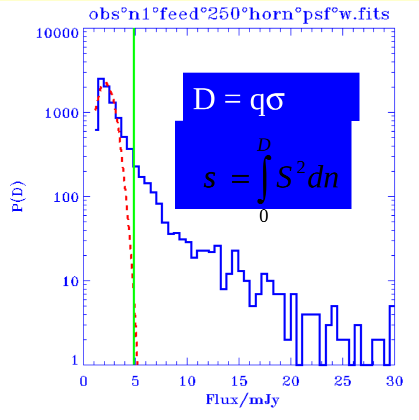
c.f. 5 sources in

Hughes et al. 1998
Nature 394 241



Classic Treatment for "confusion"

(Condon 1974)



$$s = \int_0^D S^2 dn$$

Power-law counts

$$\frac{dn}{dS} = -kS^{-g}$$

Euclidean

$g = 5/2$

$$s = \left(\frac{q^{3-g}}{3-g}\right)^{\frac{1}{g-1}} (k\Omega_{\text{effective}})^{\frac{1}{g-1}}$$

$$\Omega_{\text{effective}} = \int [f(q,f)]^{g-1} d\Omega$$

$$n_q = \frac{1}{q^2}\frac{3-g}{g-1}\Omega^{-1}{}_{\text{effective}}$$

$$n_q = \frac{1}{3q^2}\Omega^{-1}{}_{\text{effective}}$$

(S. Oliver)

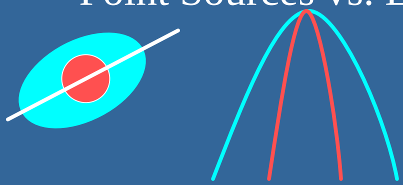
Confusion limits for Herschel

l /mm	70	120	175	250	350	500
D/m	3.5	3.5	3.5	3.5	3.5	3.5
w /arc^2	13.9	40.7	86.6	176.8	346.4	707.0
n5	12469	4243	1995	978	499	244
4.3s	0.74	3.2	11	18.6	20	16.6

Last row is flux at which number of sources hits the 4.3σ confusion limit threshold using various independent models

Limits to Super-Resolution

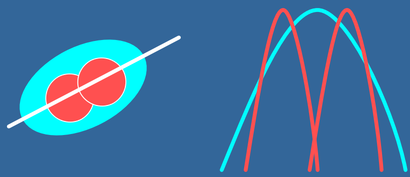
- Point Sources vs. Extended Sources



$$\frac{q_{Natural}}{q_{Super}} \propto N^{1/4}$$

Lucy 1991
Proc. 3rd ESO/ST-ECF data analysis workshop eds Grosbøl & Warmels

- 2 Point Sources vs. Extended Source



$$\frac{q_{Natural}}{q_{Super}} \propto N^{1/8}$$

Lucy 1992
AJ, 104, 1260

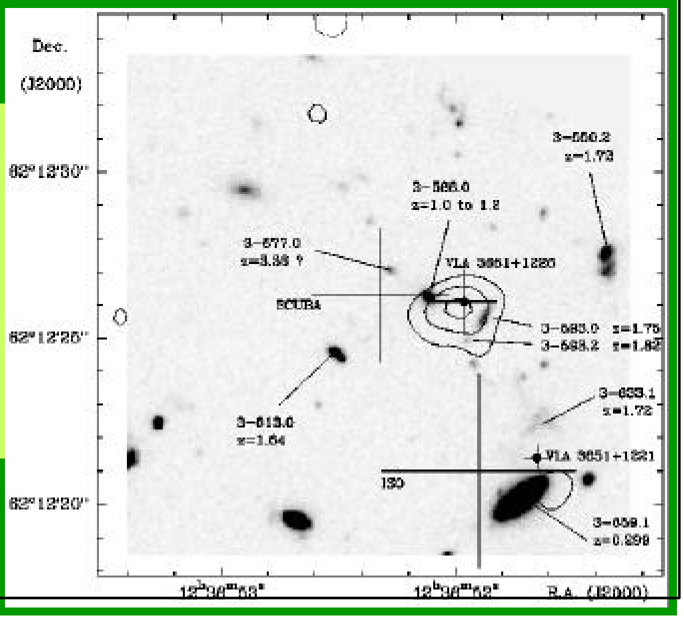
Lucy 1992
Astron Astro 261, 706

(S. Oliver)

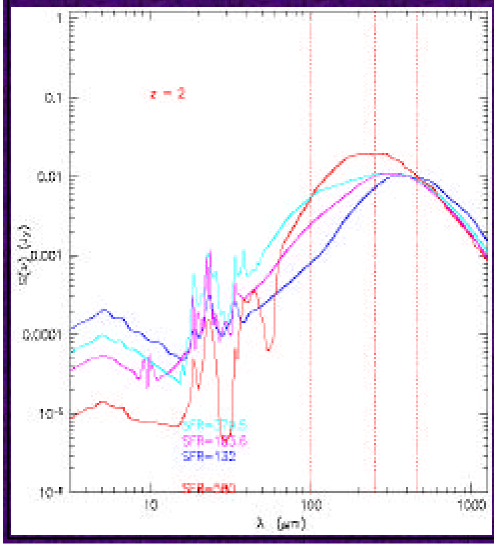
The problem of a large beam

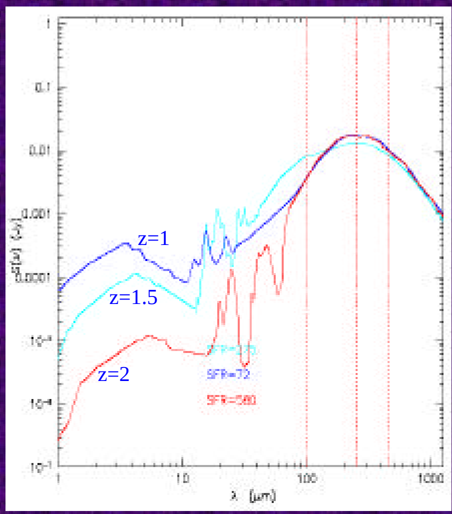
1200 µ map of the brightest SCUBA selected source HDF850.1 (Downes et al. 1999)

(source possibly identified with obj. 3-593.0 at z=1.75)

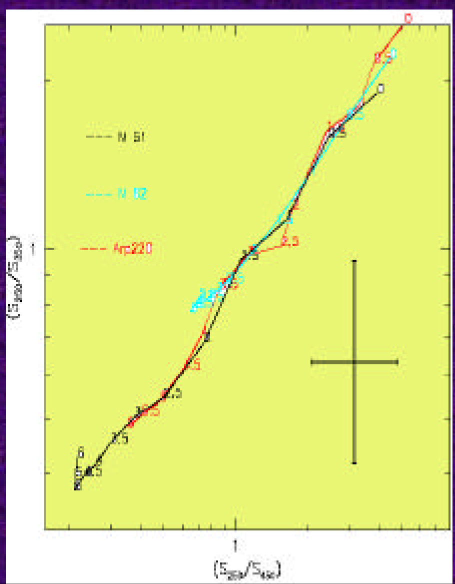


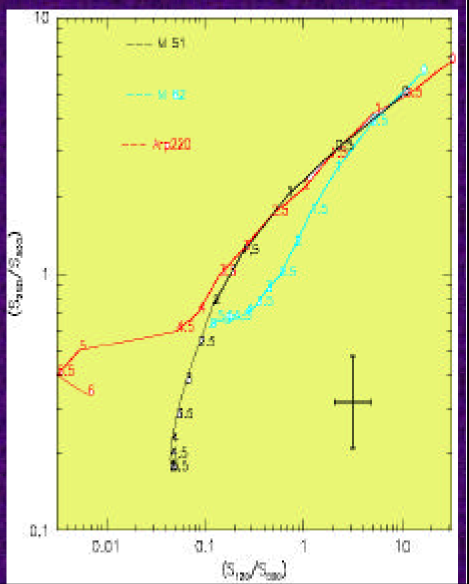
Degeneracies in the long-λ galaxy spectra





Estimate of the redshift from FIR photometry including or not a channel at short wavelengths





PACS SURVEYS

- **Covering the same fields with PACS would be desirable:**
  - Reduce the errorbox and ease identification
  - Improve the IR SED information, to allow physical insight and photometric redshift
- **Unfortunately, simultaneous SPIRE-PACS coverage will be possible only on small areas, due the lower PACS mapping speed** (moderate FOV, long integrations required)

➡ SPIRE Surveys could eventually need drammatic effort of follow-up with ALMA o other mm arrays

SKY AREAS FOR THE SURVEYS

- **Fairly obvious requirements:**
  - to avoid regions of intense Galactic “cirrus” emission
  - to avoid areas of intense Zodiacal emission
  - prefer areas with good visibility by the observatory
  - prefer areas with data at complementary ? (optical, radio, X, IR)
  - prefer areas in which the eventual follow-up would be easy/possible

Confusion by Galactic Cirrus

$$\frac{s}{1\text{mJy}} \approx \left(\frac{l}{100\,\mu\text{m}}\right)^{2.5}\left(\frac{D}{1\text{m}}\right)^{-2.5}\left(\frac{B(l)}{1\text{MJysr}^{-1}}\right)^{1.5}$$

From Gautier et al. (1992, AJ 103, 1313) and
Helou & Beichman (1990, Proc. 29th Liege Int. Astro. Colloq. ESA SP-314).

Equating $20s_{\text{cirrus}} = 4.3s_{\text{source}}$

Factor of ~5 is safety margin ensuring 2x better than Marano at 175µm

Normalising to B_{100} using cirrus spectrum (Rowan-Robinson et al 1992, MNRAS, 258, 787)

(S. Oliver)

The SIRTF "SWIRE" Survey

SIRTF Wide-area IR Extragalactic Survey, Legacy Programme
(Lonsdale et al.), ~ 70 sq. deg. at all SIRTF photometric bands
Constraints more severe than for FIRST
should be able to detect first FIRST source in IRAC bands

Table A-2: Expected SWIRE Performance:
Noise and Sensitivity Estimates

Wavelength	*Cirrus noise,1 s # (1 MJy/sr at 100 mm)*	*Extragalactic * Confusion noise, 1 s*	*SWIRE photometric sensitivity, 1 s*
3.6 mm	*18 nJy*	*40 nJy*	*1.4 mJy*
4.5mm	*40 nJy*	*150 nJy*	*1.9 mJy*
5.8 mm	*60 nJy*	*150 nJy*	*5.5 mJy*
8.0 mm	*300 nJy*	*1 mJy*	*6.5 mJy*
24mm	*2.0 mJy*	*85 mJy*	*0.09 mJy*
70mm	*0.1 mJy*	*37 mJy*	*0.55 mJy*
160mm	*2.0 mJy*	*36 mJy*	*3.5 mJy*

 # model of Gautier ** derived from Franceschini model confusion distribution*

SWIRE Survey Fields

Target	**RA**	**Dec**	b	**100µ BKG**	**E(B-V)**	**Area**(sq.deg.)
XMM-LSS	02 26	-04 30	-18	1.1	0.35	10
Chandra-S	03 45	-30	-48	< 0.4	0.12	5
Lockman Hole	10 40	57	+44	< 0.4	0.10	15
Lonsdale Hole	15 10	56	+68	< 0.4	0.20	10
ELAIS S1	00 35	-43 28	-43	< 0.4	0.12	15
ELAIS N1	16 09	56 27	+74	< 0.4	0.10	10
ELAIS N2	16 37	41 16	+62	< 0.4	0.11	5

Herschel Cosmological Surveys

⇕

Large Coordinated Programs

(with a strong involvement of the PI teams and ICC staff)

LOCAL GALAXY SURVEYS WITH SPIRE

Walter Gear

Local Galaxy Surveys

- Zero redshift benchmark for cosmological surveys
- Spatial distributions of Dust, gas and metals in galaxies
- Statistical study of dust opacity and chemical evolution/metallicity
- Environmental impact - field vs clusters

Local Galaxy Surveys

- SPIRE will be able to make the first galaxy survey more or less unbiased wrt to dust temperature.
- Because of increased sensitivity cf. e.g. SCUBA will be able to detect dwarfs and ellipticals not just spirals
- An all sky survey at 250 μm to ~40 mJy could detect ~ 10^6 galaxies out to ~12000 km/s (z~0.02). A 400 sq.deg. Survey should find 1000s.

Low-z benchmark

- Very little presently known about statistical properties of local Universe at submm/FIR
- SCUBA surveys made of IRAS and optically selected samples (Eales, Dunne et al ...)
- But, IRAS only sensitive to warm dust and optical biased to low dust so not making unbiased survey.
- Also small sample sizes (~100)

Spatial distributions of dust, gas and metals

- Radn pressure could hold up extended dust halos, (also superwinds) which could provide significant obscuration for optical surveys
- Some evidence from ISO of dust extended beyond starlight, but no evidence from SCUBA for this...
- SPIRE should provide sensitivity, calibration accuracy and dynamic range to do this properly

Spatial distributions.

- Does dust link primarily with molecular or atomic gas ? Contradictory evidence here so far..
- Does gas to dust ratio track metallicity ?
- This study needs high sensitivity and spatial resolution

Dust opacity

- Holmberg (1958) ‘showed’ that there was insignificant obscuration in galaxies
- In 1980s Davies and Disney in Cardiff showed that this was subject to strong selection effects, controversy ever since...
- Best test is Lopt/Lsubmm for large (unbiased) samples of galaxies…

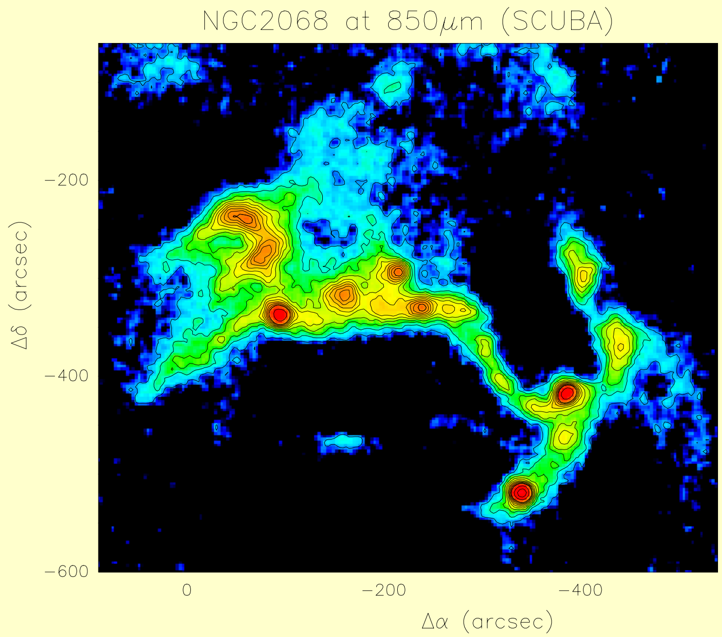
Environmental Impact

- HI stripping is well-known in clusters
- Effect of cluster environmen on dust content is not known
- As well as a large field survey therefore I would propose a large survey at least of VIRGO and preferably several nearby clusters

Star Formation Surveys with SPIRE/Herschel

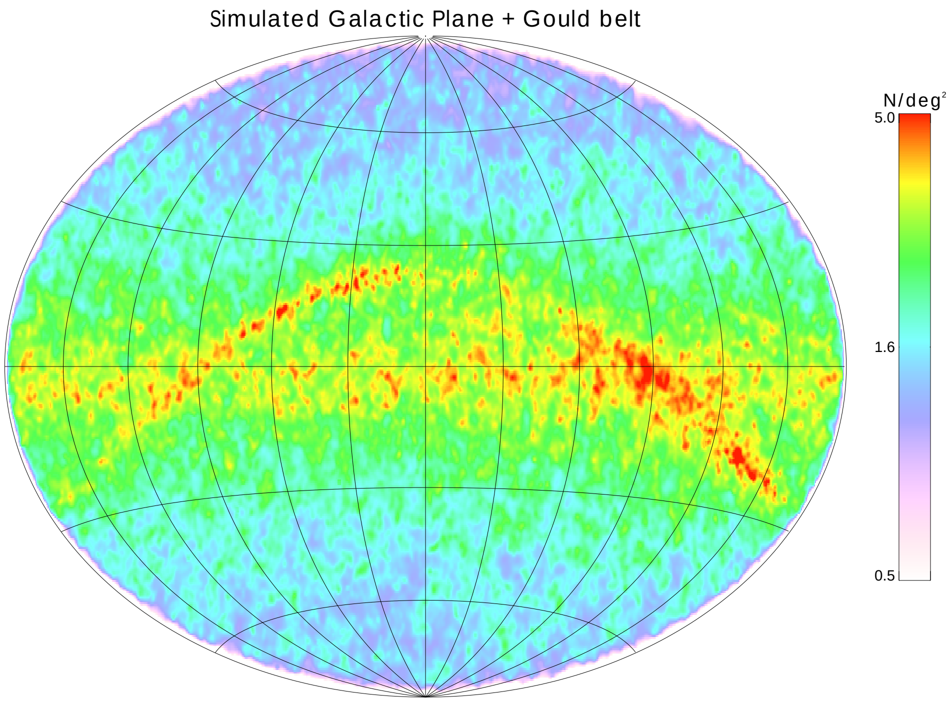
Philippe André, CEA Saclay

- Introduction
- Wide-field submm survey of the Gould belt: Origin of the IMF
- Structure of pre-stellar cores



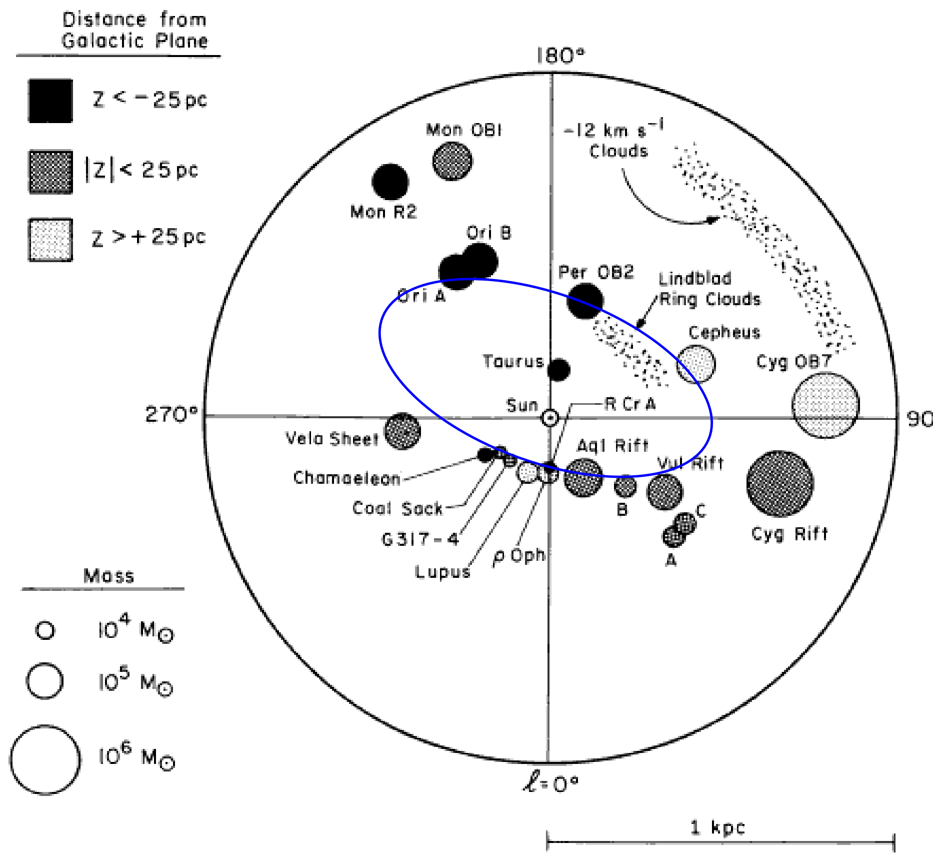
GALACTIC SURVEYS WITH SPIRE

Galactic Plane + Gould Belt



(XMM Simulation based on ROSAT: Guillout 2001)

Gould Belt and Nearby Molecular Clouds

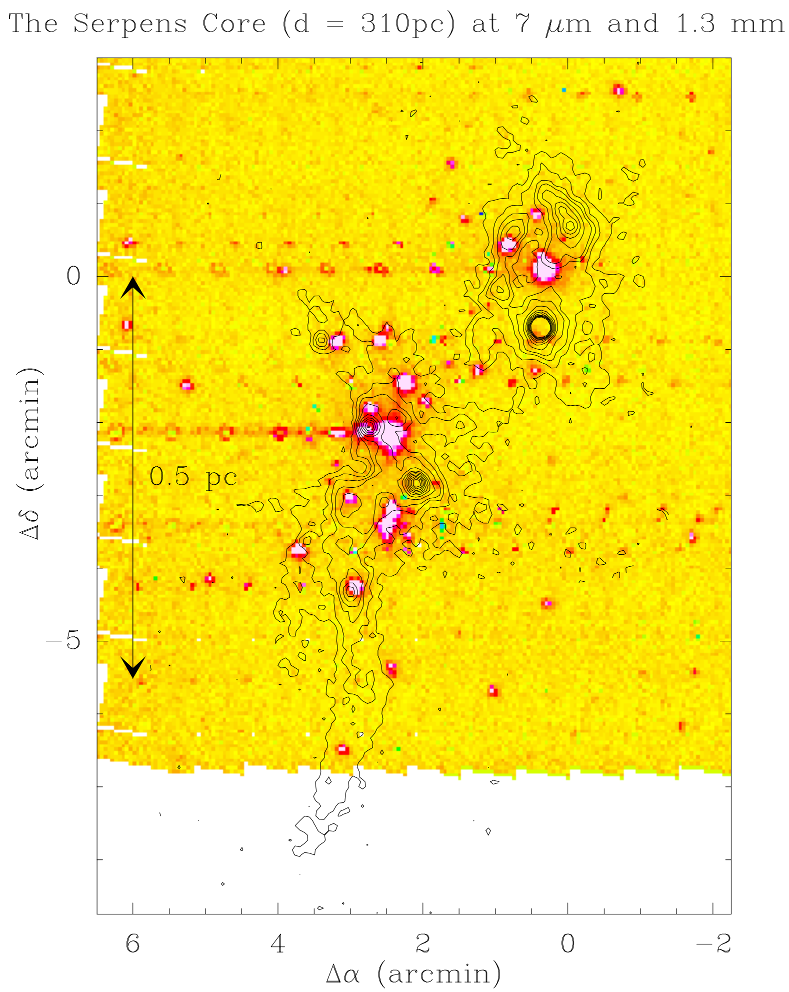


~ 20 CO cloud complexes at d < 1 kpc

(e.g. Dame et al. 1987, 2000)

--> Imaging wide fields (a few 100 deg^2) with SPIRE

Distinct Views of Embedded Clusters at IR and MM Wavelengths

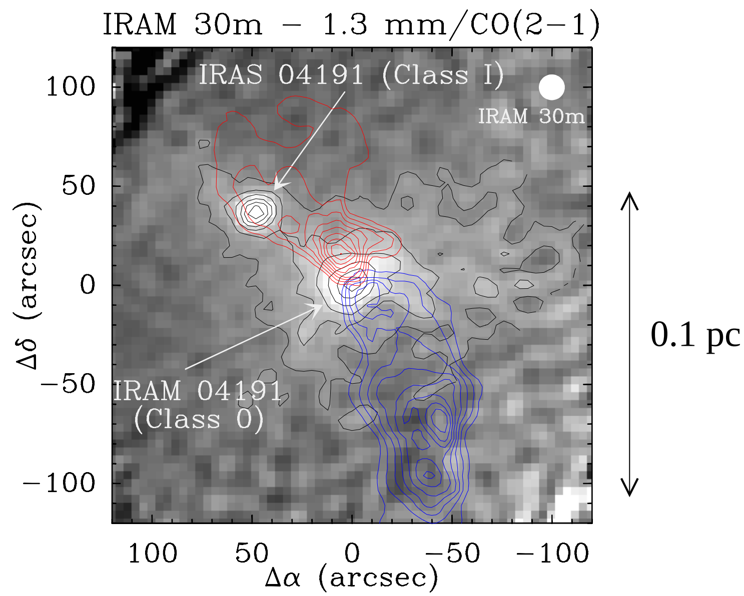


(ISOCAM & IRAM 30m, Kaas et al. 1999)

- **Near-/Mid-IR:**
  Pre-main sequence population, i.e., already formed young stars ($M_\star >> M_{circum\star}$)
- **(Sub-)Millimeter:**
  Separate population consisting of young accreting protostars ($M_\star << M_{env}$ – Class 0 objects) and starless protocluster condensations
- → Need to study the (sub)mm population to gain insight into the origin of the IMF

CLASS 0 OBJECTS:

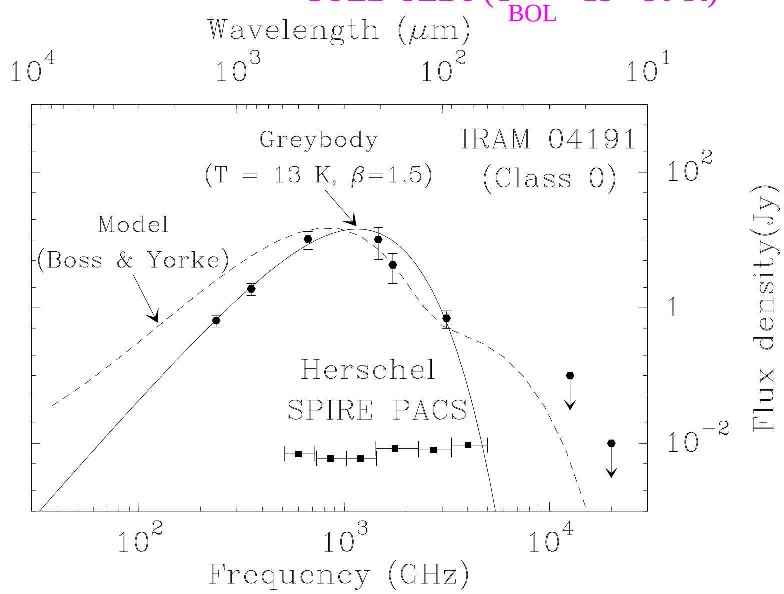
PROTOSTARS IN THE BUILD-UP PHASE



André, Motte, Bacmann (1999)

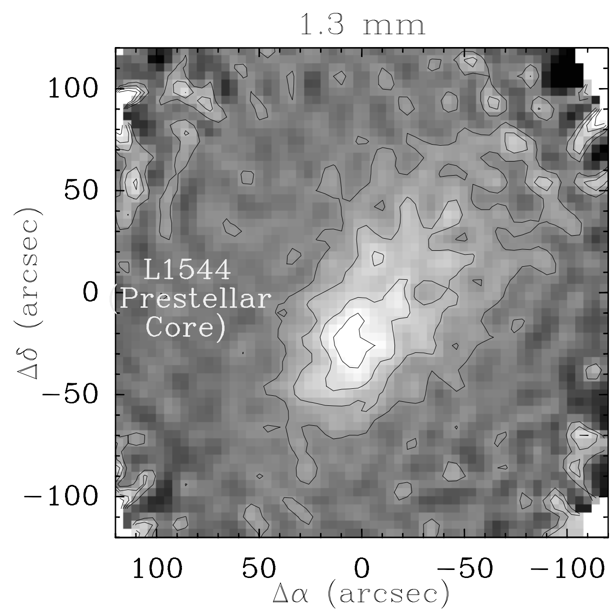
MASSIVE ENVELOPES ($M_{ENV} > M_*$)

COLD SEDs ($T_{BOL} \sim$ 15 - 50 K)



PRESTELLAR CORES:

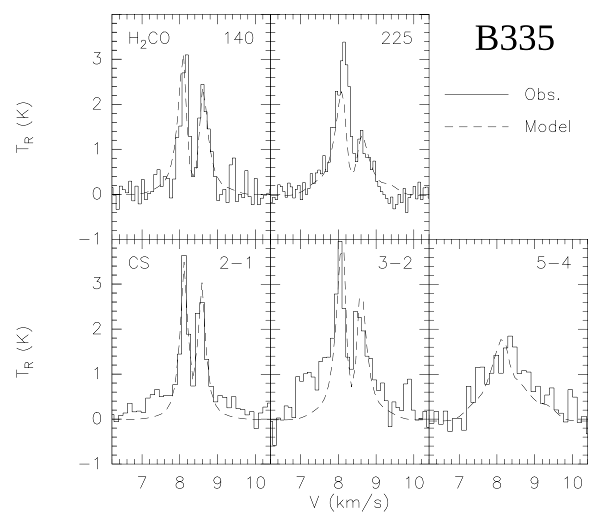
THE PROGENITORS OF PROTOSTARS



Ward-Thompson et al. (1999, 2001)

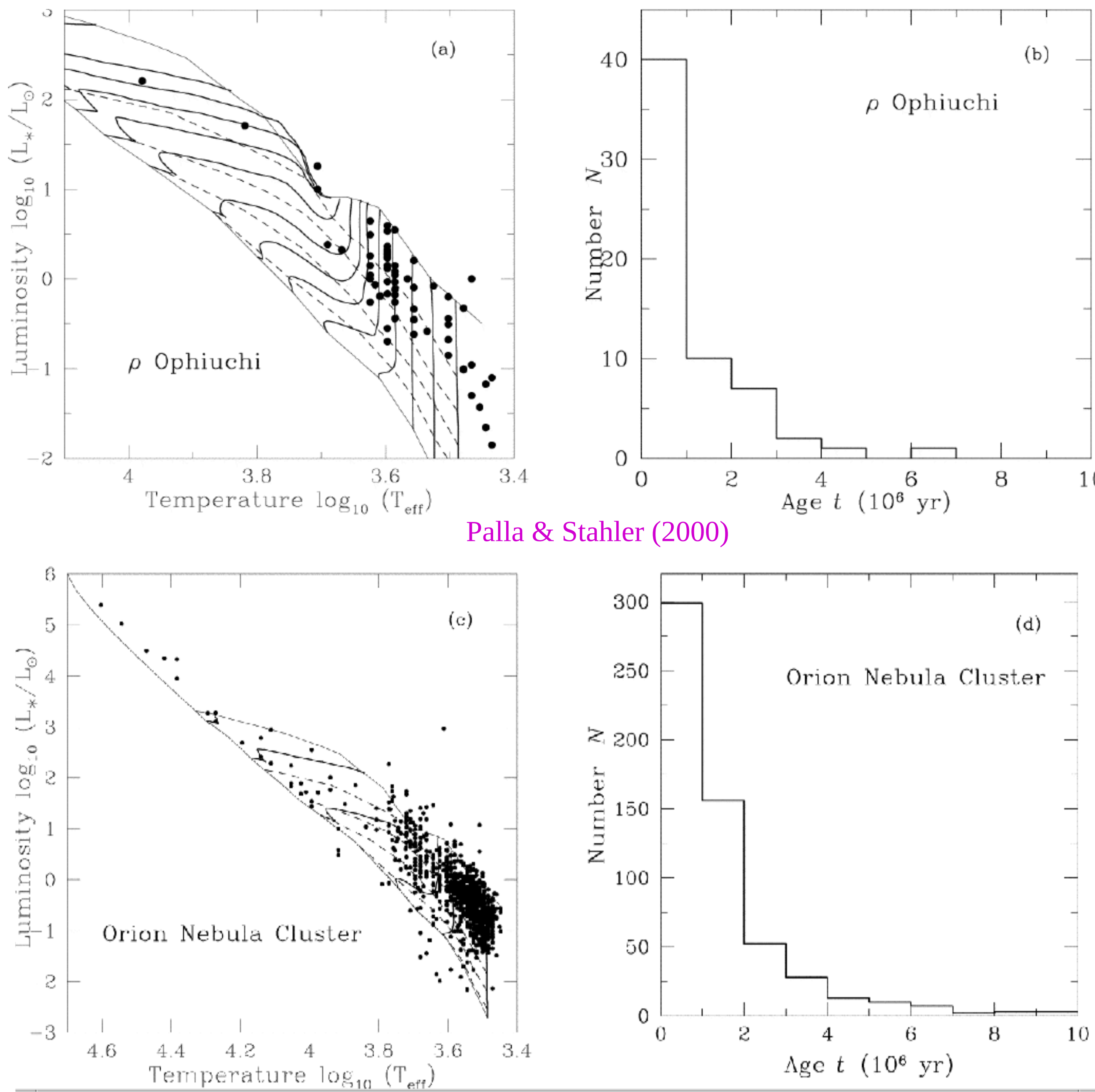
GRAVITATIONALLY BOUND ($M_* = 0$)

EXTENDED INFALL MOTIONS



e.g. Evans (1999) + Myers et al. (2000)

HINTS OF ACCELERATING STAR FORMATION IN NEARBY CLOUDS



Palla & Stahler (2000)

==> EXPECT LARGE NUMBER OF PRESTELLAR CONDENSATIONS AND CLASS 0 PROTOSTARS

Proposed Survey of the Gould Belt with SPIRE/Herschel

SPIRE 250–500 μm survey of $\gtrsim 500$ deg^2 in both active and quiescent nearby ($d <$ 1 kpc) molecular clouds, supplemented by PACS 70–170 μm imaging of nearby proto-clusters and selected areas (~ 30 deg^2).

Examples of Targets:

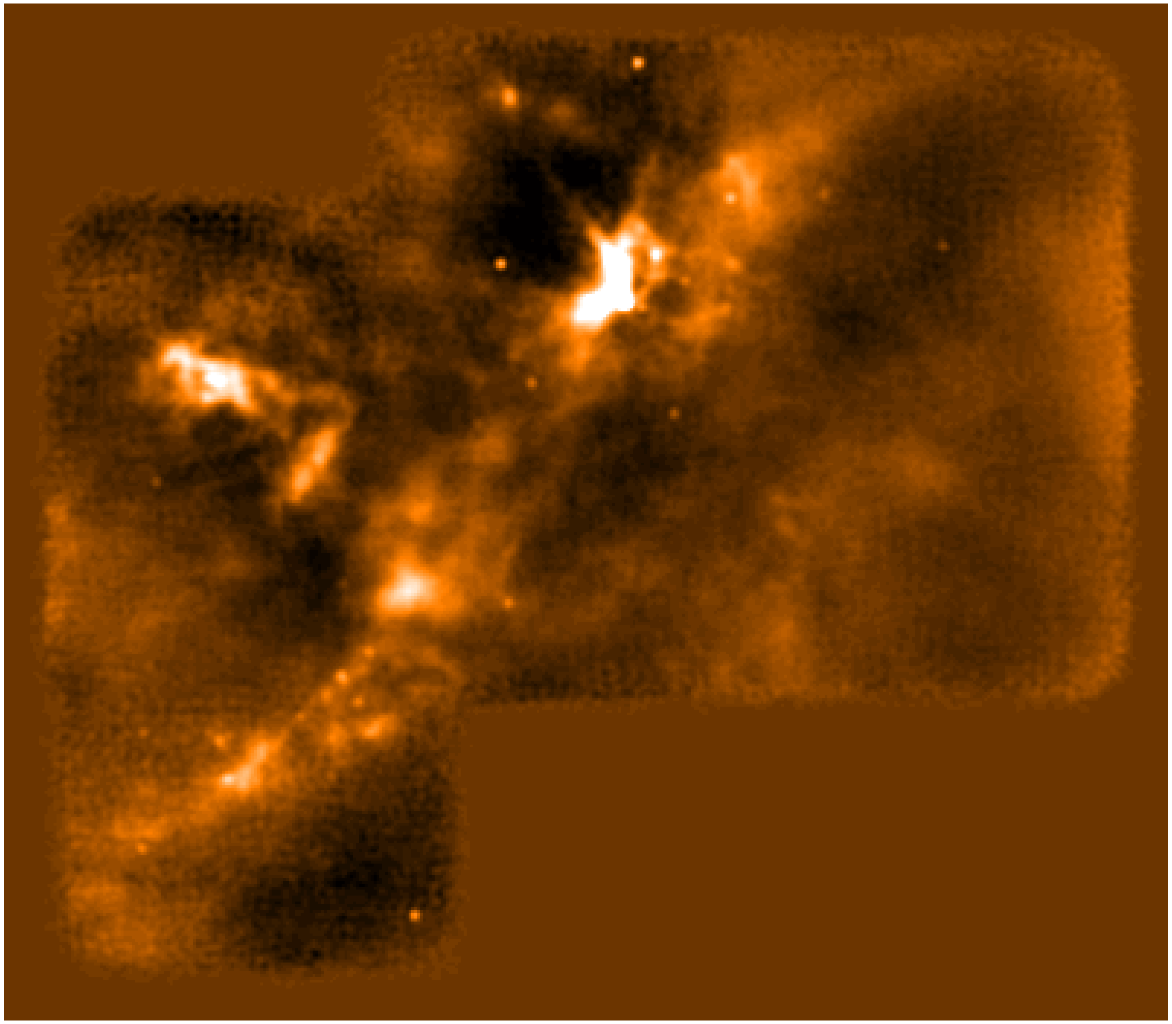
- **At ~ 150 pc: Taurus, ρ Oph, CrA, Lupus, South coal sack, Chamaeleon, $\rightarrow \sim 500$ deg^2 down to rms$_{250\mu} \sim 24$ mJy ($>$ cirrus noise ~ 10 mJy) $\rightarrow \sim 8$ days with SPIRE. Mass sensitivity: $\sim 0.03\,M_\odot$ at the 10σ level.**

- **At ~ 450 pc: Orion A & B $\rightarrow \sim 30$ deg^2 down to cirrus noise/2 ~ 13 mJy $\rightarrow \sim 2$ days. Mass sensitivity: $\sim 0.1\,M_\odot$ at the 5σ level.**

$\rightarrow$ Total SPIRE time needed to survey densest portion of Gould belt: $\sim$ 20–30 days

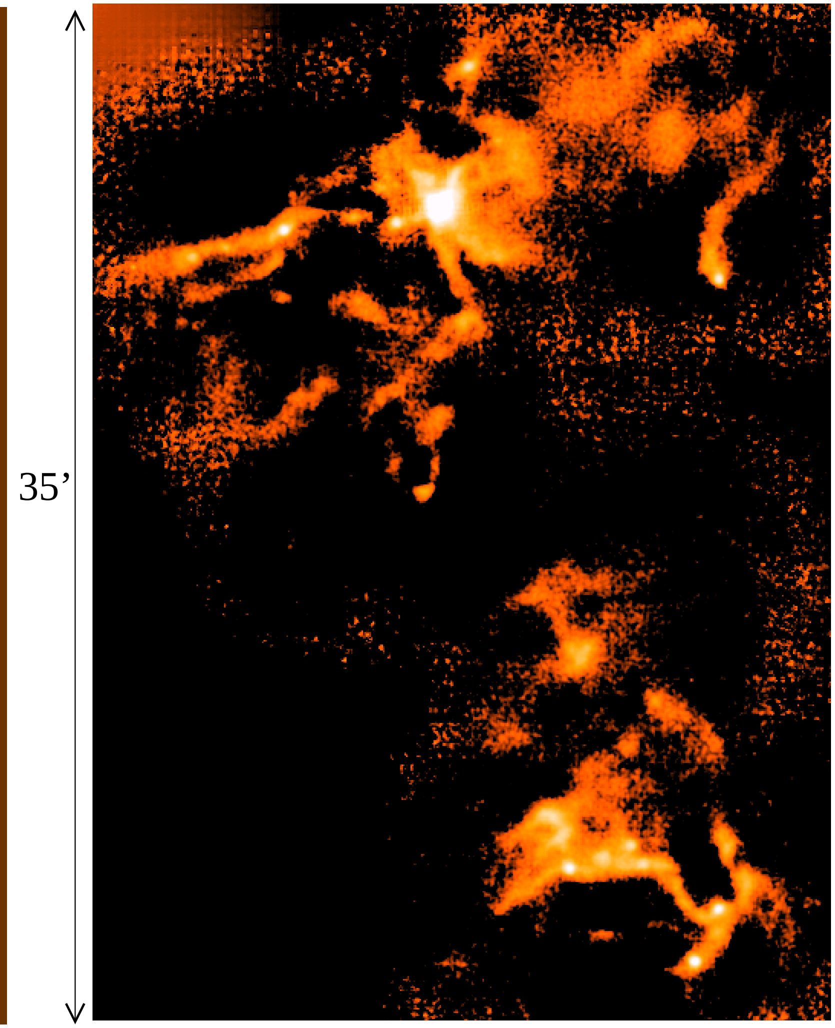
Examples of Recent Ground-Based 850 μm Continuum Imaging Surveys

SCUBA Mosaic of Rho Ophiuchi



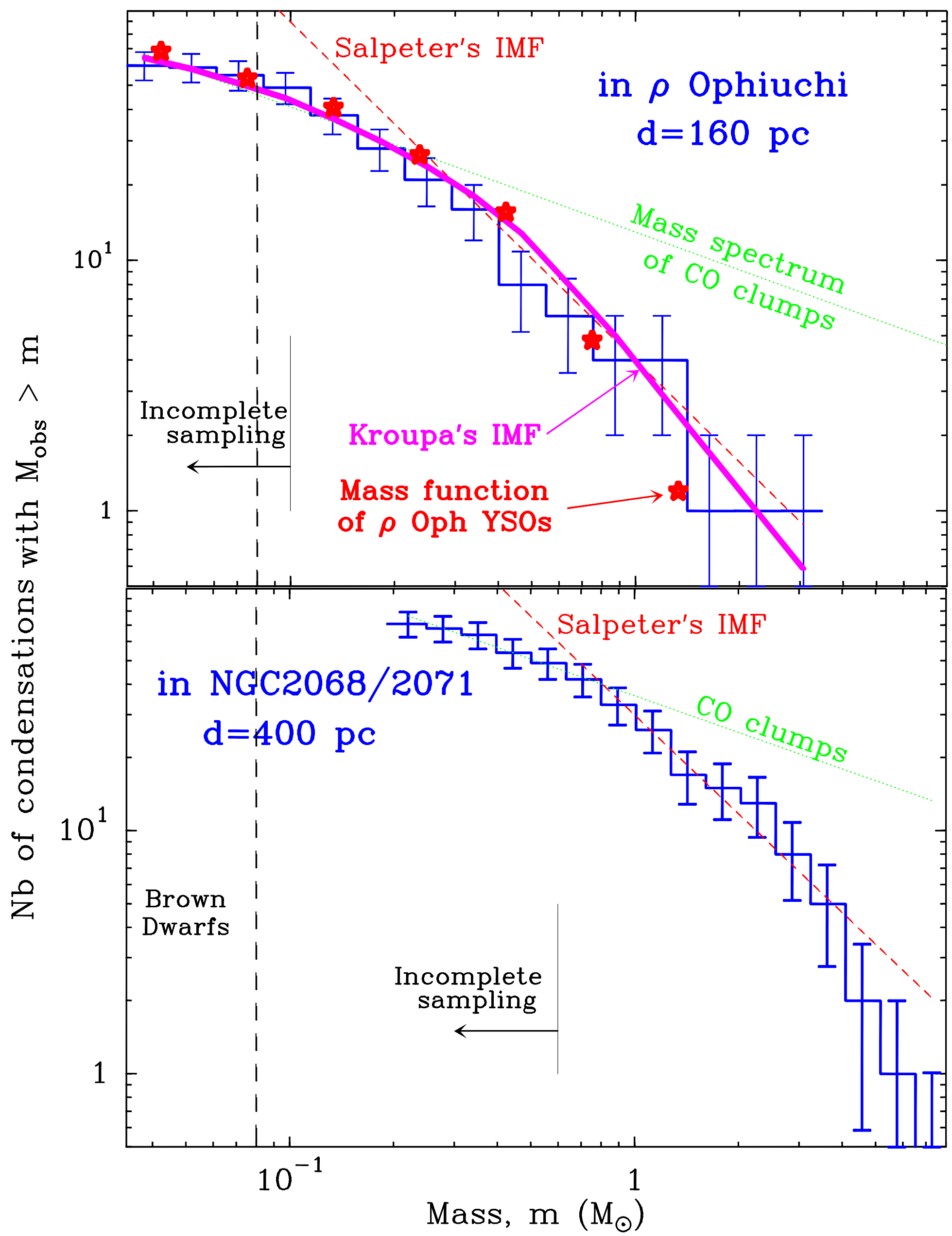
Johnstone, Wilson, Moriarty-Schieven et al. (2000)

SCUBA Map of NGC 2068/71 in Orion B



Motte, André, Ward-Thompson, Bontemps (2001)

THE MASS SPECTRUM OF PRESTELLAR CONDENSATIONS IS SIMILAR TO THE STELLAR IMF

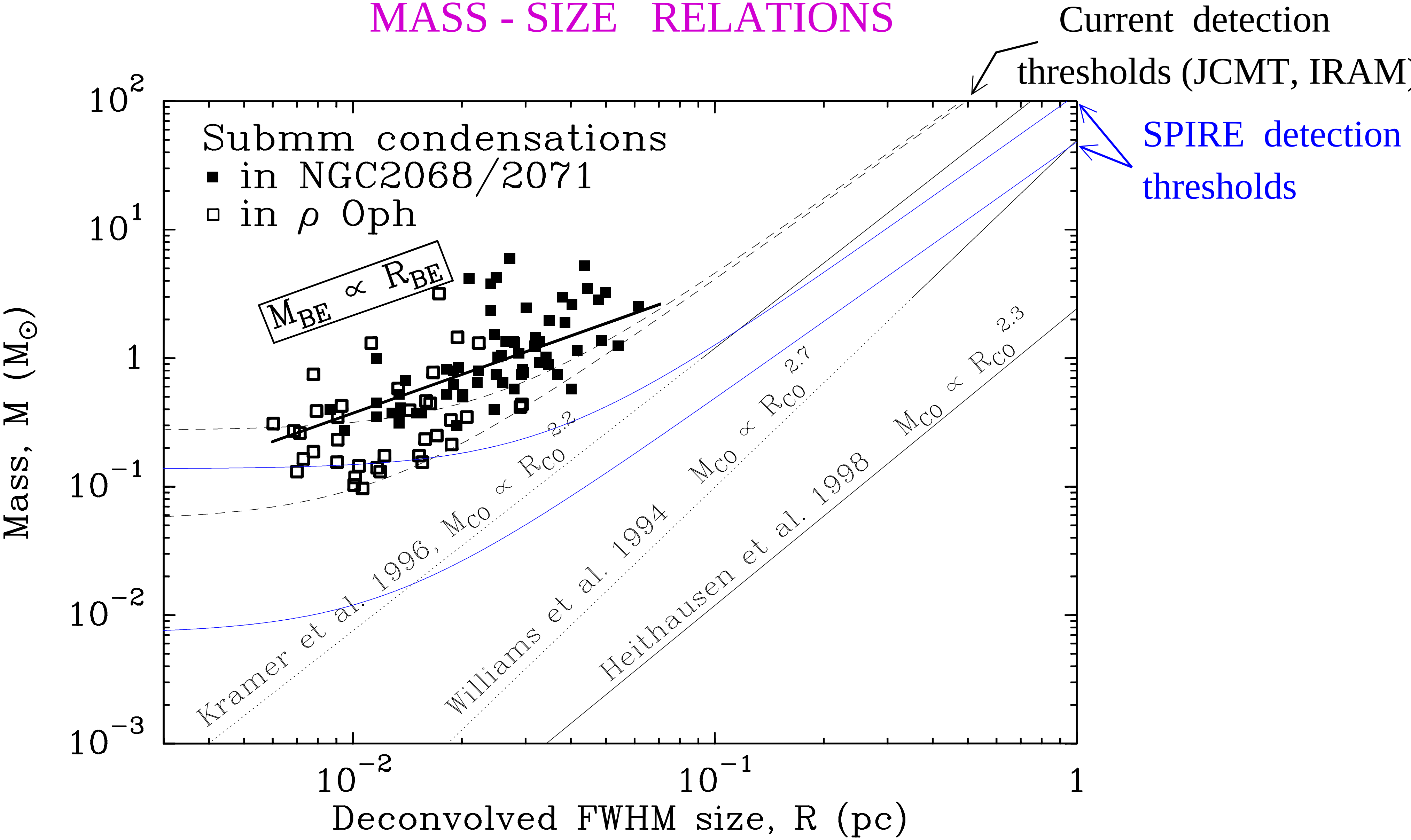


-> Suggests the IMF is partly determined by fragmentation at the prestellar stage

+ High (> 50%) star formation efficiency within the prestellar condensations detected in the submm continuum = direct progenitors of individual stars

Motte, André, Neri (1998) + Bontemps et al. (2001) + Motte et al. (2001)

MASS - SIZE RELATIONS



Unique Potential of Herschel for Star Formation Surveys

- **Mapping speed: SPIRE $\sim$ 2–3 orders of magnitude faster than SCUBA or SOFIA.**

- **Sensitive to low surface brightness structures as opposed to ALMA.**

- **Angular resolution sufficient to resolve individual condensations in nearby clouds, contrary to SIRTF, ASTRO-F ...**
(NB: Self-similarity of the ISM breaks down below $\sim$ 5000-15000 AU.)

- **Much less prone to cirrus confusion noise ($\times 50$) than smaller telescopes (SIRTF, ASTRO F ...).**

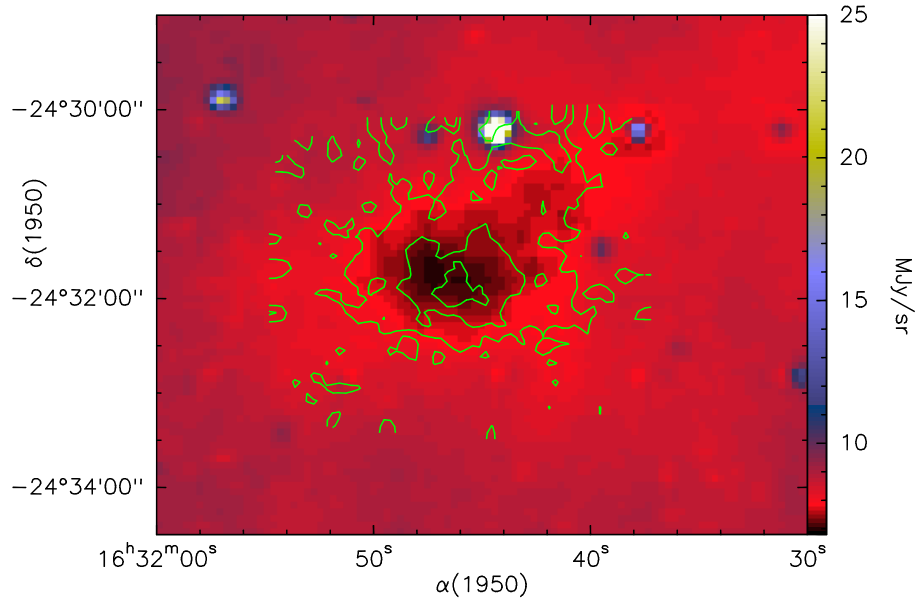
- **Combined PACS/SPIRE wavelength coverage ($\sim$ 70–500 μm) is ideal to probe the temperature/density structure of prestellar cores and the evolution of dust properties.**

RADIAL STRUCTURE OF PRE-STELLAR CORES

L1689B SEEN

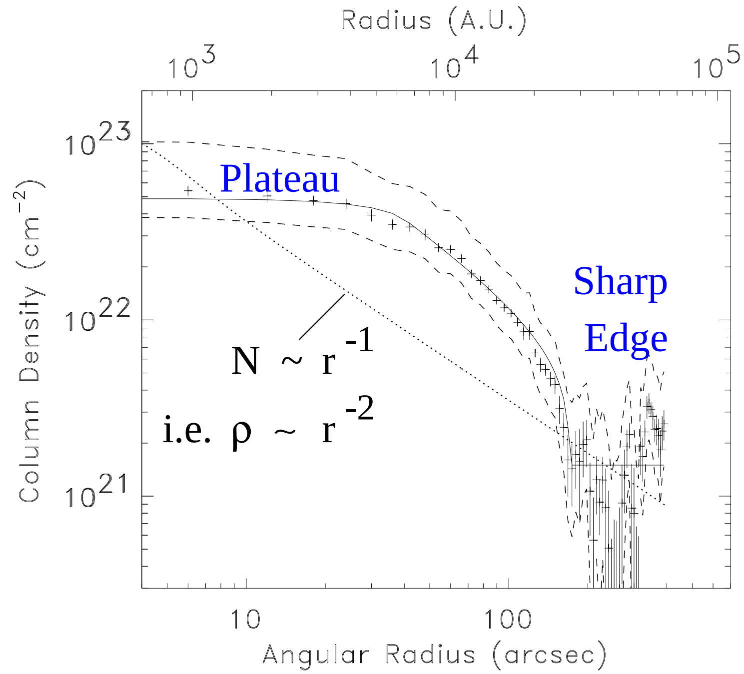
IN ABSORPTION BY ISOCAM AT 7 μm

IN EMISSION BY IRAM (30m) AT 1.3 mm



Bacmann et al. (2000) + André, Ward-Thompson, Motte (1996)

→ COLUMN DENSITY PROFILE



PRESENT ASSUMPTIONS:

ABSORPTION: UNIFORM BACKGROUND/FOREGROUND

EMISSION: UNIFORM DUST TEMPERATURE/OPACITY

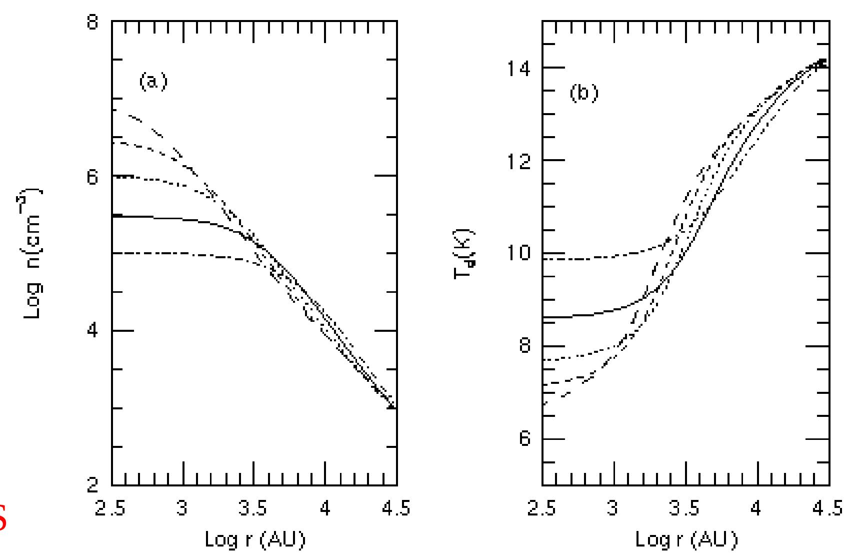
$$I_\nu \; \alpha \; N_{H_2} \times B_\nu(T) \; \kappa_\nu$$

WITH FIRST (SPIRE/PACS):

SIMULTANEOUS DETERMINATION OF THE

TEMPERATURE AND COLUMN DENSITY PROFILES

MODEL PREDICTIONS

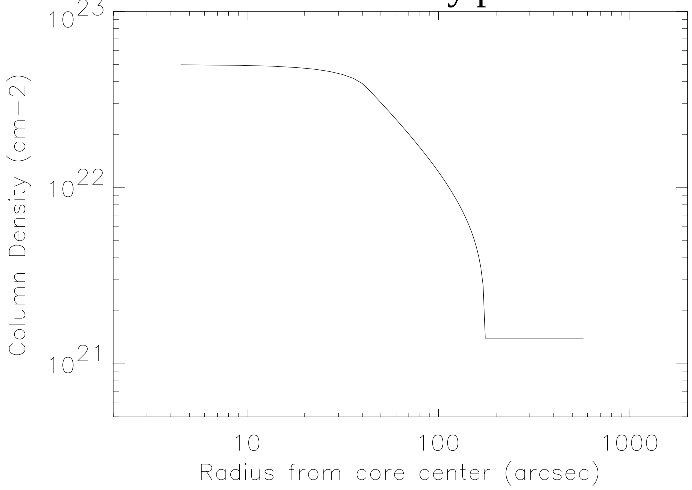


Evans et al. (2001)

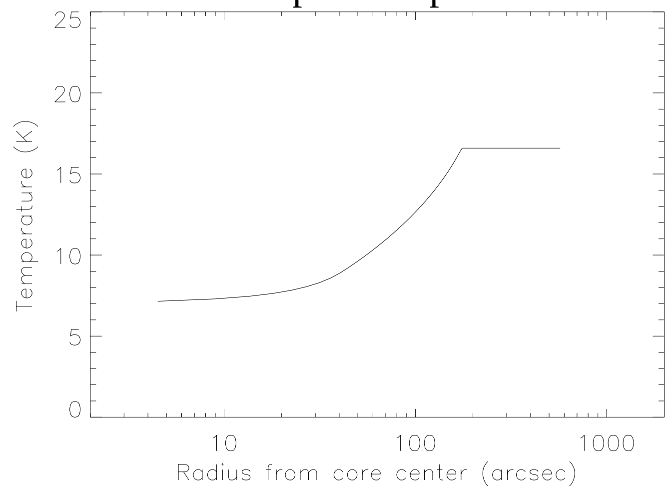
SIMULATIONS OF MULTI-BAND MAPPING OBSERVATIONS WITH HERSCHEL

Input model core

Column density profile

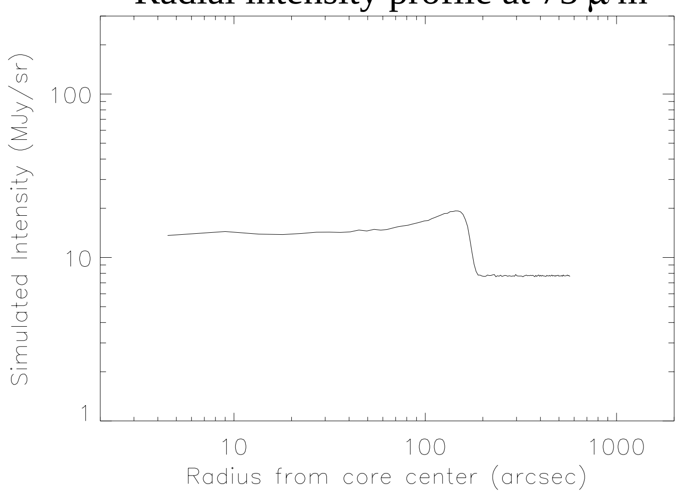


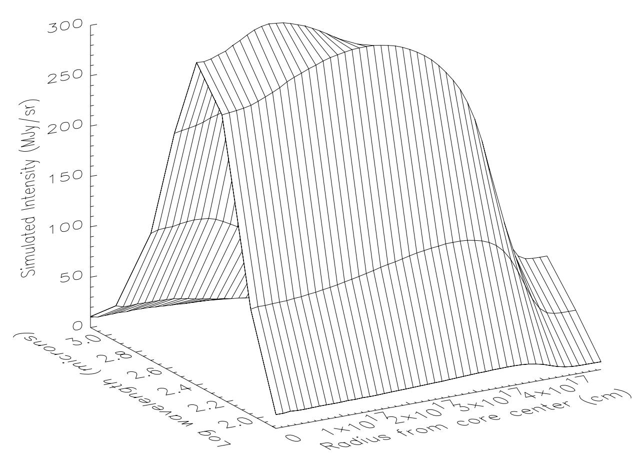
Temperature profile



Intensity profiles at 6 Herschel bands (75-500 μ m) + 850 + 1250 μm

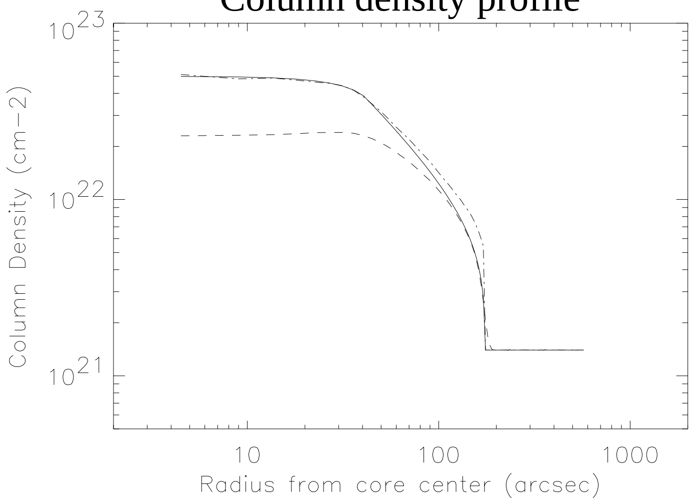
Radial intensity profile at 75 μ m



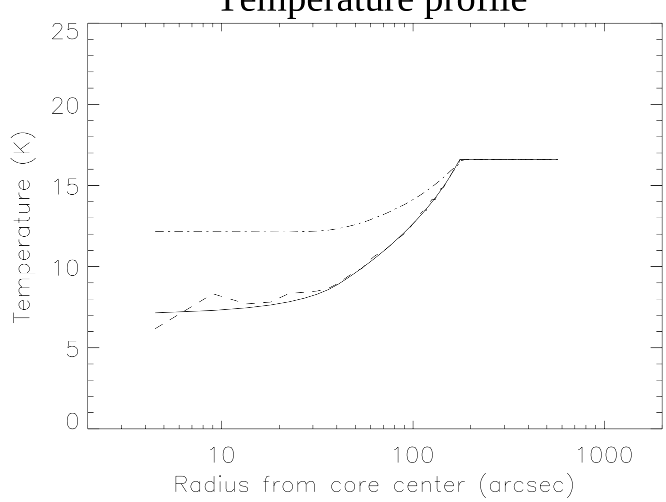


Reconstructed core structure

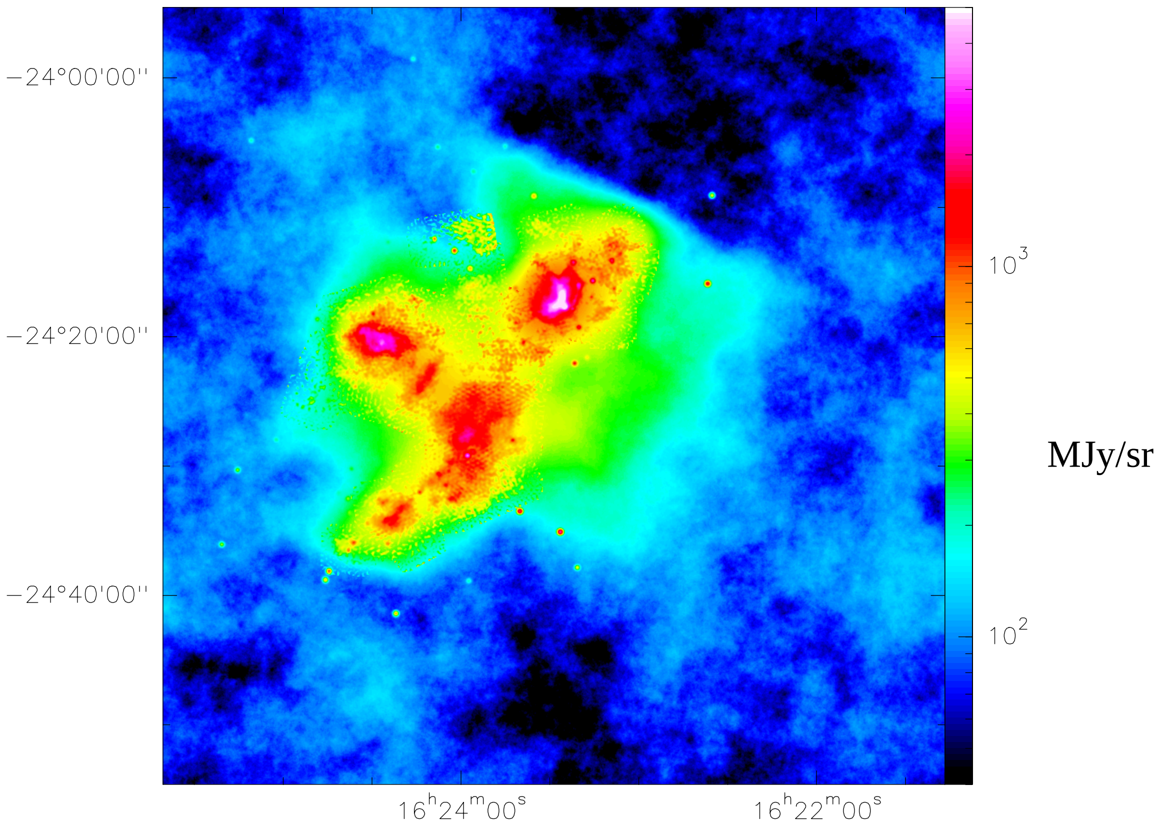
Column density profile

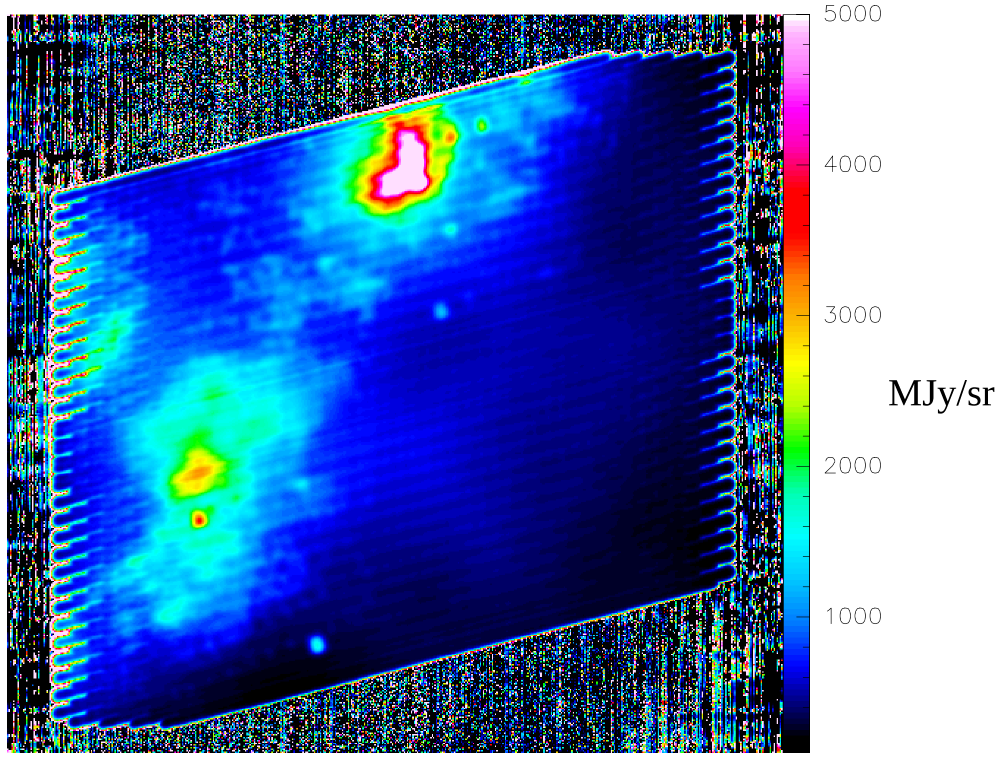


Temperature profile



SIMULATIONS OF SPIRE SURVEY OF RHO OPH AT 250 μ m





Conclusions

• A wide-field survey of the Gould belt with SPIRE/PACS would provide a complete census of young protostars and pre-stellar condensations in nearby cloud complexes down to the proto-brown dwarf regime.

→ Lifetimes of the various stages

→ Temperature & density structure of condensations → Collapse initial conditions

→ Evolution of dust properties

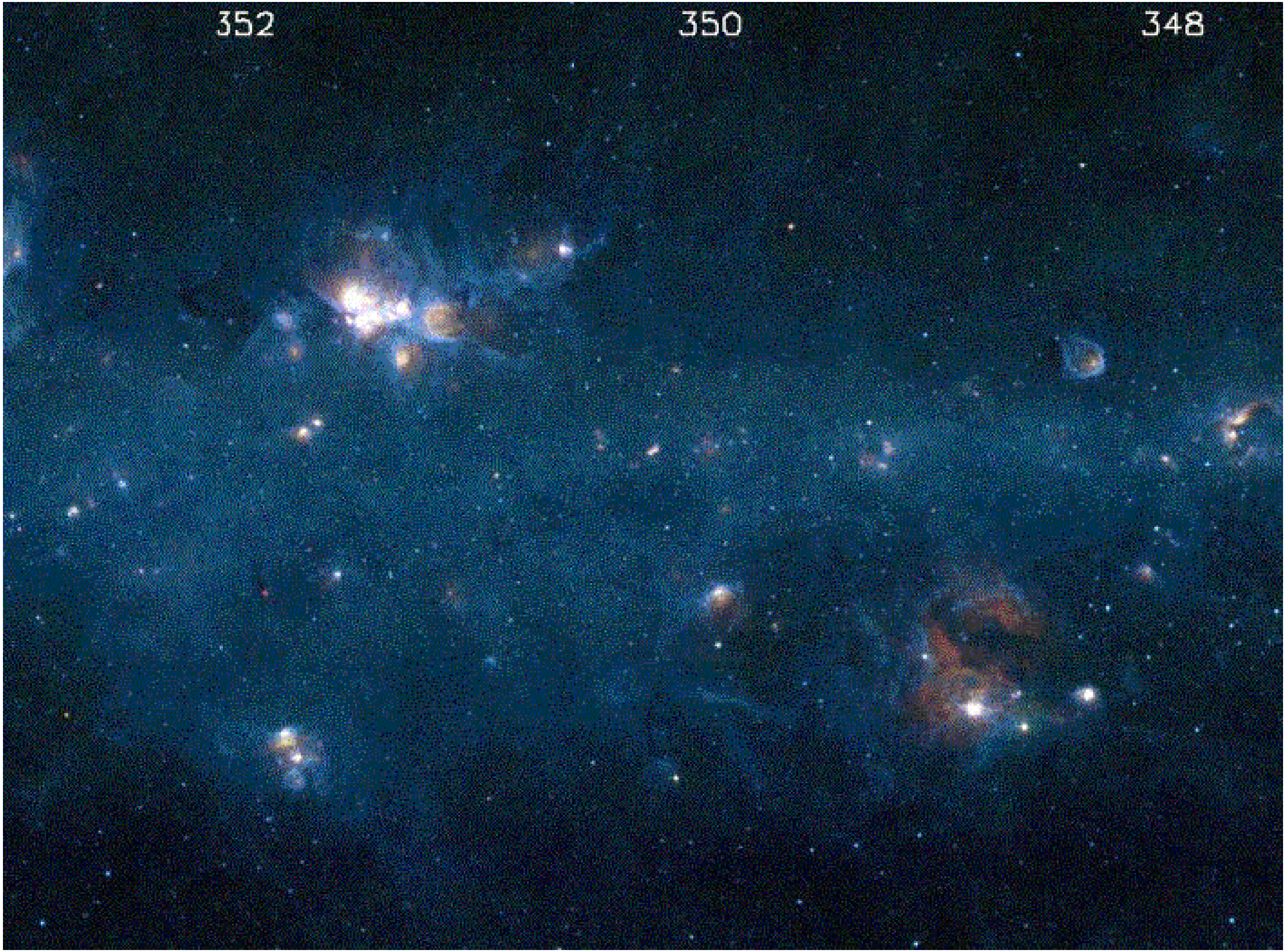
→ Luminosity & mass functions → Origin and universality of the IMF ?

• Follow-up detailed spectroscopic studies with HIFI and ALMA to constrain dynamical properties and chemical evolutionary states.

SPIREGAL

A Proposal for a Galactic Plane Survey with SPIRE

Brice Swinyard
Sergio Molinar
Martin Cohen


352
350
348

Science Issues

- Distribution and Mass Function of Star Forming Regions *throughout* the Galaxy

- Structure of ISM at its emission peak with unprecedented resolution. SPIREGAL will detect all 240μm emission seen by COBE/DIRBE.

- Dust Envelopes
  - HII Regions - *All* objects reported in the major radio surveys.
  - PNe - 25% of the sources in Acker et al. catalogue
  - AGB stars

Calibration issues

- **Flat fielding** to recover diffuse emission
- **Off-plane b-strips** to go down to the noise level

Select suitable positions via ground based 350/450 μm observations. Use MSX technique of a few dedicated long strips along the galaxy

- **Monitor system stability** via frequent observations of:
  - UCHII
  - PPN
  - AGB
  - "Normal" stars

- Build a network of calibrators via ground based 350/450 μm observations with:
  - Widest GLON coverage
  - Widest flux range
- Theoretical SED modelling
- Can also use stars cf. Work done for ISOPHOT by Cohen

- X-Calibration
  - Planck/HFI (beamsize?)
  - Cobe/DIRBE (beamsize?)
  - Astro-F/FIS
  - IRAS
  - ISO

Data Reduction & Analysis

- Dedicated Reduction Pipeline
  - Flexible & Tunable
  - Limited friendliness to the general user

- Point Source Catalogue
  - Quality Assessment

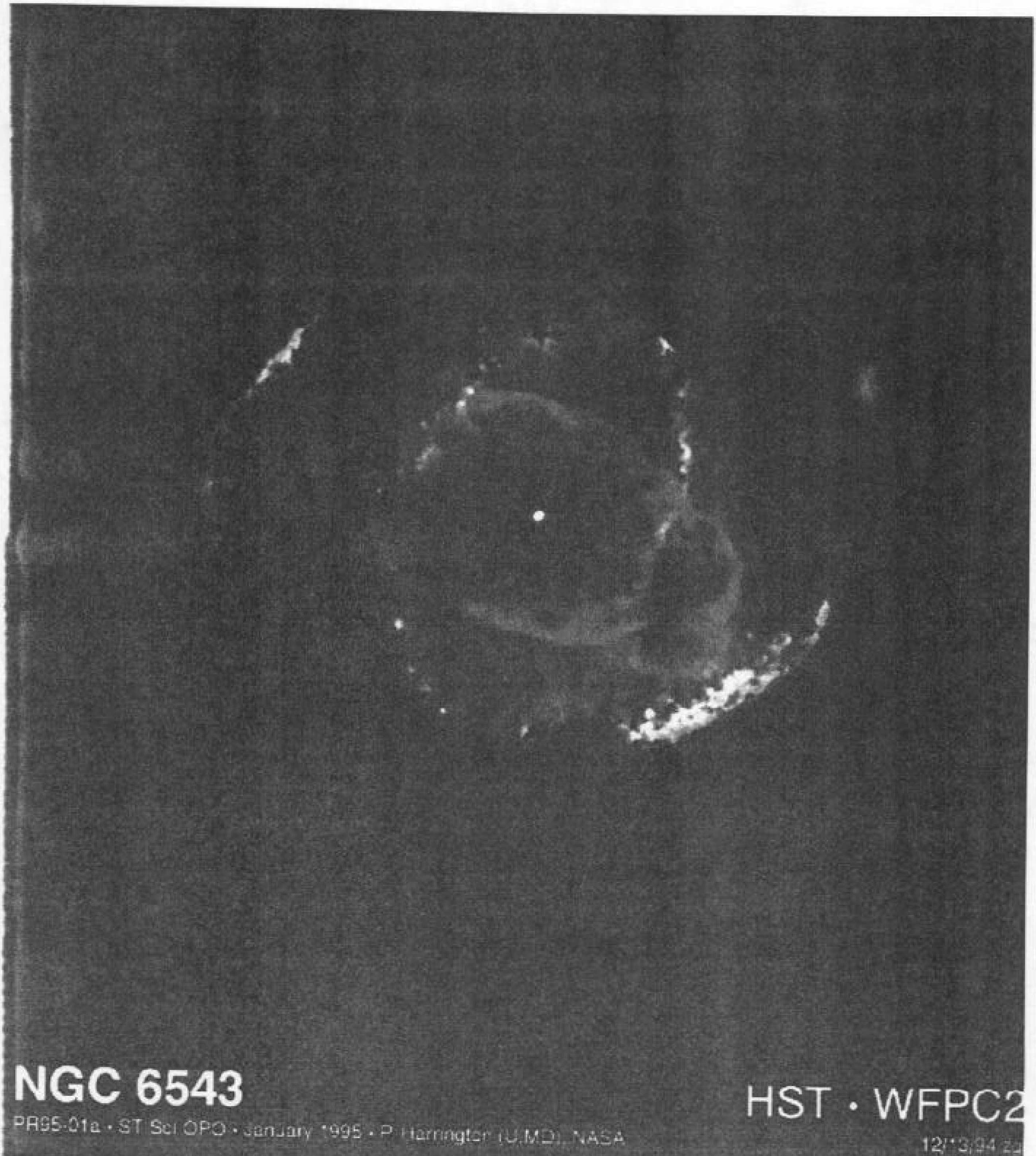
- Xcomparison Surveys
  - Planck (whole galaxy coarse)
  - SITRF GLIMPSE (b<1 deg 70<|l|<30 2")
  - MSX (whole galaxy 20")
  - IRAS (whole galaxy 1')
  - ASTRO-F/FIS (whole galaxy?)
  - NVSS (VLA)/MOST (whole galaxy 1')
  - HI (whole galaxy 1')
  - CO (Columbia)

The 'missing mass' problem in stellar evolution

Almost all stars with initial main sequence masses < 5-8 M☉ end their evolution as white dwarfs, whose maximum mass is 1.4 M☉ and whose mean mass is 0.6 M☉. Stars currently becoming PNe had initial main sequence masses > 1.3 M☉.

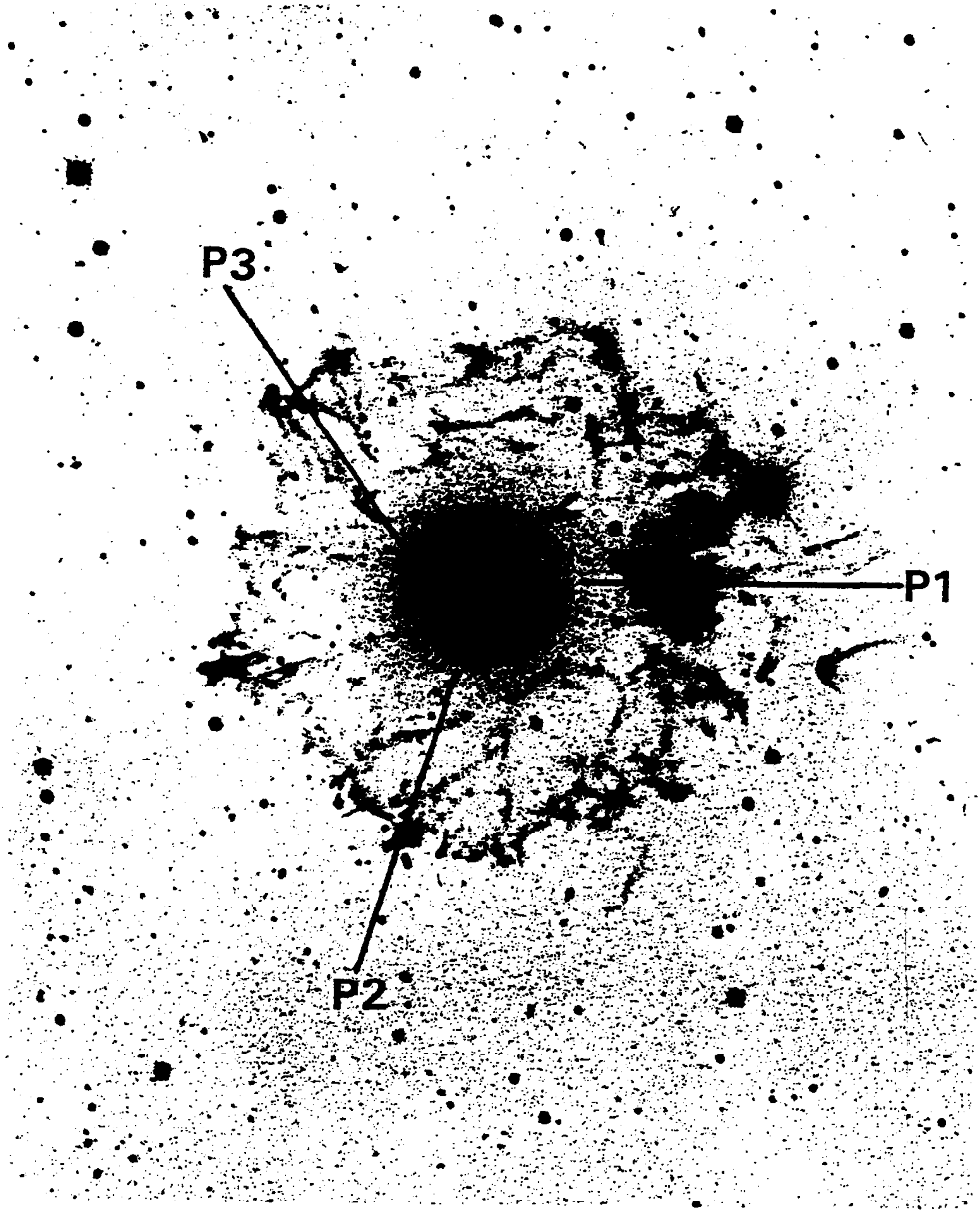
Typical PN nebular masses are 0.3-0.5 M☉ (produced by a final AGB superwind). For a mean central star mass of 0.6 M☉, this implies that ≳ 0.2-0.4 M☉ was lost during earlier evolutionary phases. When?

Dust particles are the best tracers of previous ejection events. The ejected dust will be heated by the IS radiation field to temperatures of 10-30K
⇒ Planckian emission peaks between 300 - 100 μm. ∴ SPIRE and PACS will be ideal instruments for imaging such fossil dust shells.


NGC 6543
PR95-01a · ST ScI OPO · January 1995 · P. Harrington (U.MD), NASA
HST · WFPC2

Cats-Eye Nebula NGC 6543

[NII] 6584Å image



Ejecta at radii out to 4 arcmin

Mauron and Huggins (A and A, 359, 707, 2000)

223″×223″ CFHT

HST

74″.5×74″.5

V-band

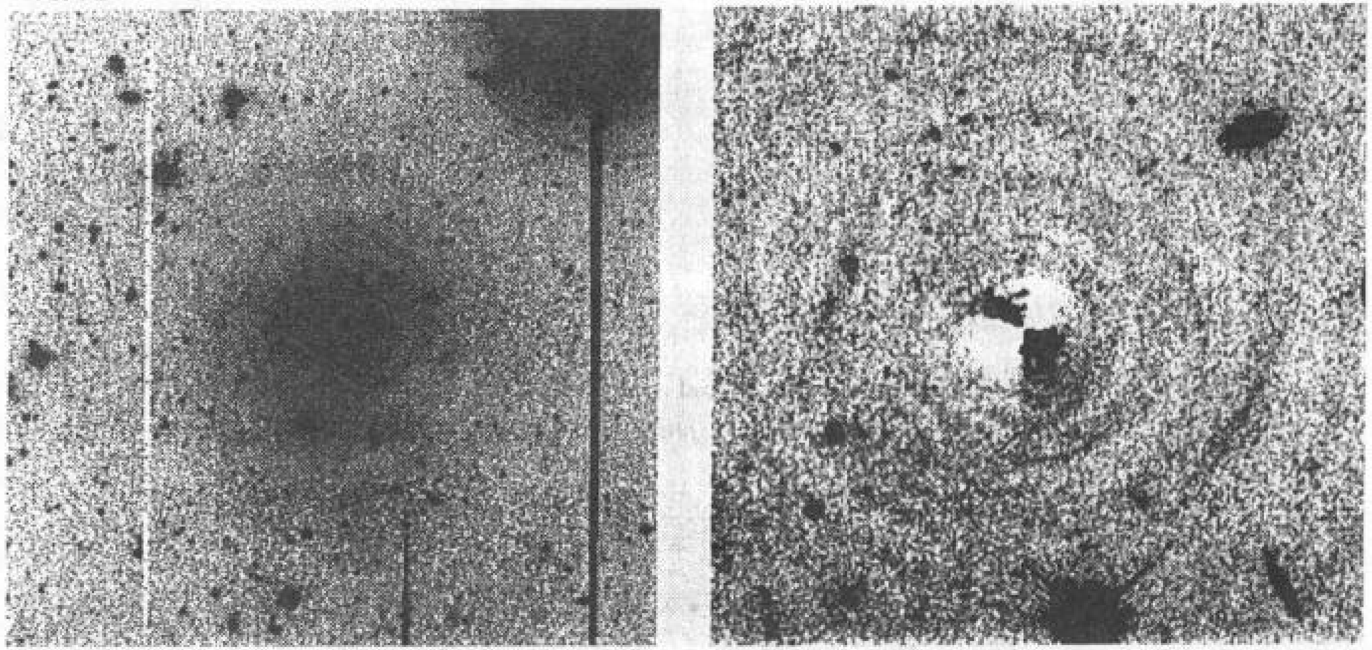


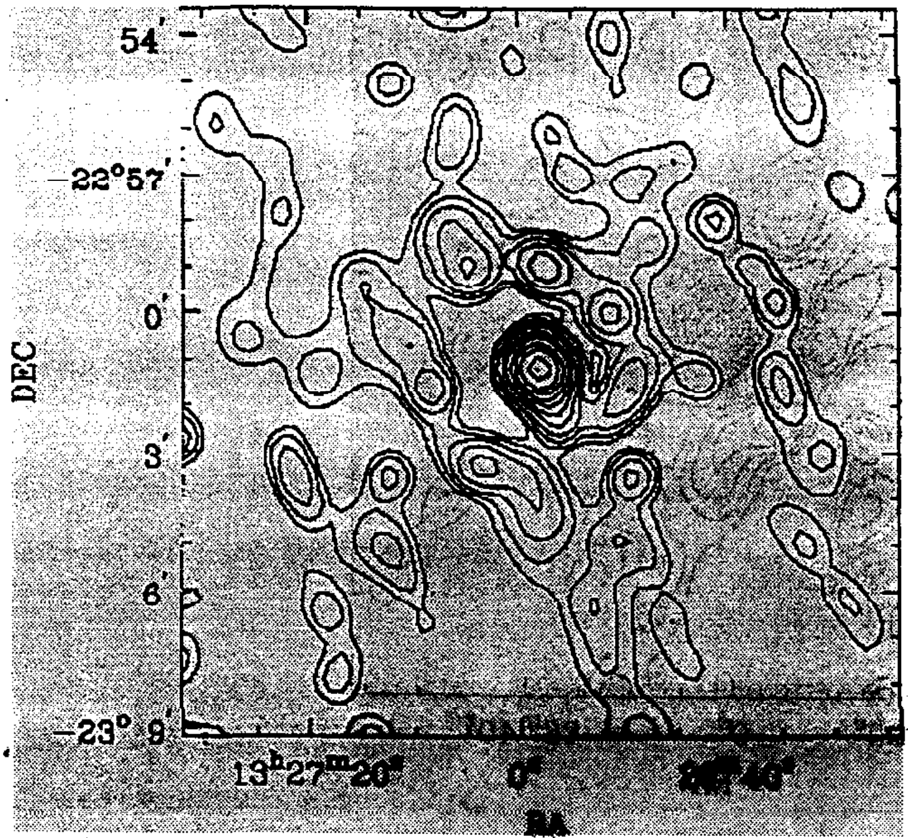
Fig. 1. The multiple shells in IRC+10216. *Left panel:* CFHT *V*-band image. Field is 223″ × 223″, with North to the top, East to the left. *Right panel:* HST WFPC2 wide-*V* image, with a smooth, radial profile subtracted to enhance visibility of the shells. The field is 74″.5 × 74″.5, rotated 26° counter-clockwise with respect to left panel.

Field of IRC+10216

Shells are typically spaced at intervals of 5″–20″ ⇒ intervals of 200–800 yrs. Shell/intershell density contrast ~3

Mass in the shells is ~70% of total (shell + intershell)

Hashimoto et al. (1998, A and A, 329, 213)



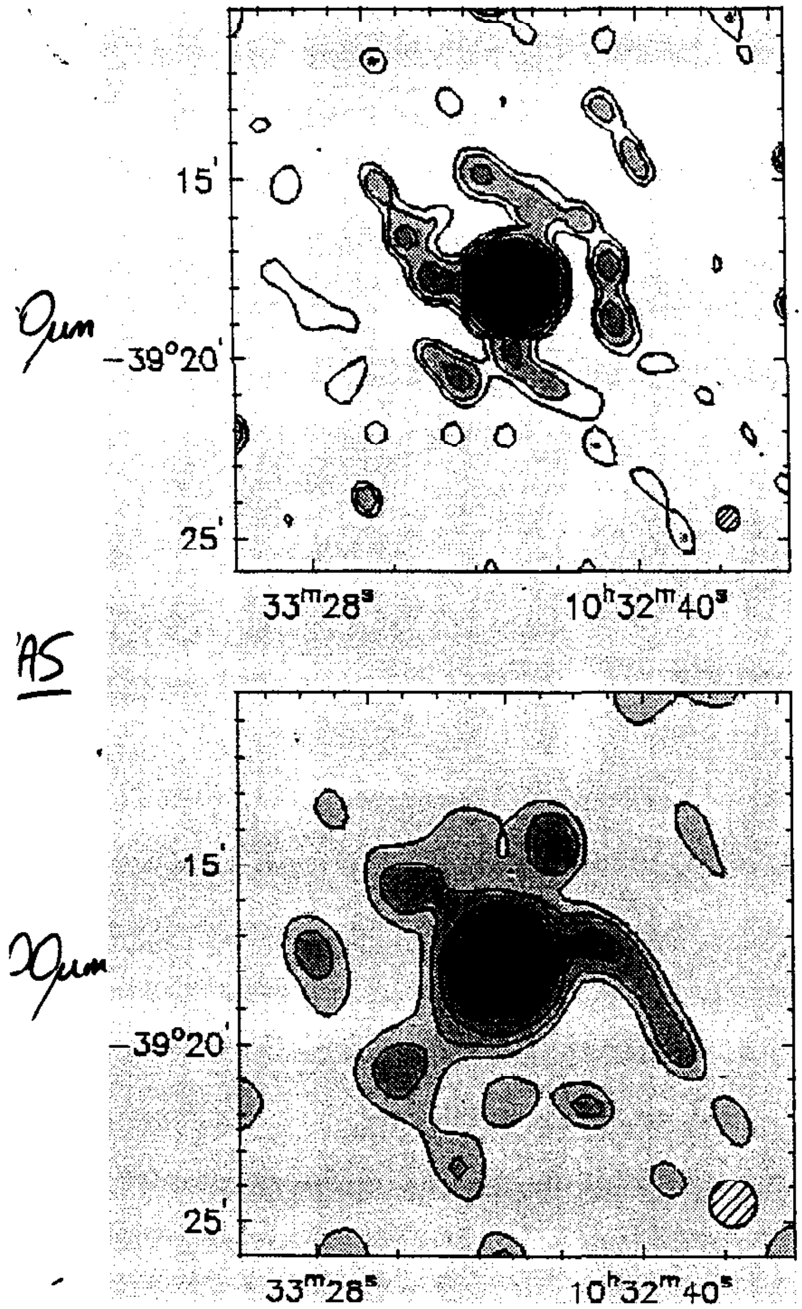
60μm IRAS image of shell around R Hya (Mira-type AGB)

Fig. 2a. IRAS 60 # m image of R Hya reconstructed by the PME techniques. Contour lines are 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, and 1024 MJy str^{-1}

6 − 8 arcmin diameter shell (Age ~10^4 yrs)
(Vexp = 10 km/s)

Very weak 10μm silicate band in spectrum of R Hya, yet strong 25μm emission
→ detached dust shell (mass loss ceased ~100 yrs ago)

Izumiura et al. (A and A, 323, 449, 1997)



U Antliae

(N-type carbon star)

Shell diameter

~ 8 - 10 arcmin

→ τ = 1.6×10⁴ yrs

→ 2×10⁴ yrs

(vexp = 21 km/s)

Fig. 1. HIRAS images of U Ant in the 60μm band (top) and the 100 μm band (bottom). The contour levels are given steps in the power of 2 in MJy sr^{-1} starting at 1 MJy sr^{-1}. The hatched circle at the bottom-right corner shows the nominal size (FWHM) of a point-like source in HIRAS images

PROGRAMME

(A)

Use SPIRE and PACS to map the environs of ~100 evolved stars between 90 and 500μm.

Targets should be chosen to cover a wide range of evolved stellar types across the HRD (evolved high mass stars as well as low and intermediate mass stars). Where possible, chosen to be at high galactic latitudes in order to minimise Galactic cirrus contamination.

SPIRE can map more quickly than PACS, so first part of survey should consist of simultaneous imaging at 250 350 and 500μm of 8x8 arcmin fields around each target: 2.5 hours per target → 1σ sensitivity of ~1.4mJy/pixel → 250 hours total.

Further 250 hrs. for follow-up imaging with PACS at 75, 110 and 175μm, for those for which SPIRE has detected shells → 6 λ's from 75-500μm will give excellent characterisation of dust shell temperatures and masses.

(B) <u>Properties of envelopes of evolved stars</u>

SPIRE 200 – 670 μm FTS
spectral survey of evolved stars
(high-, low- and intermediate-mass)
at <u>known</u> distances

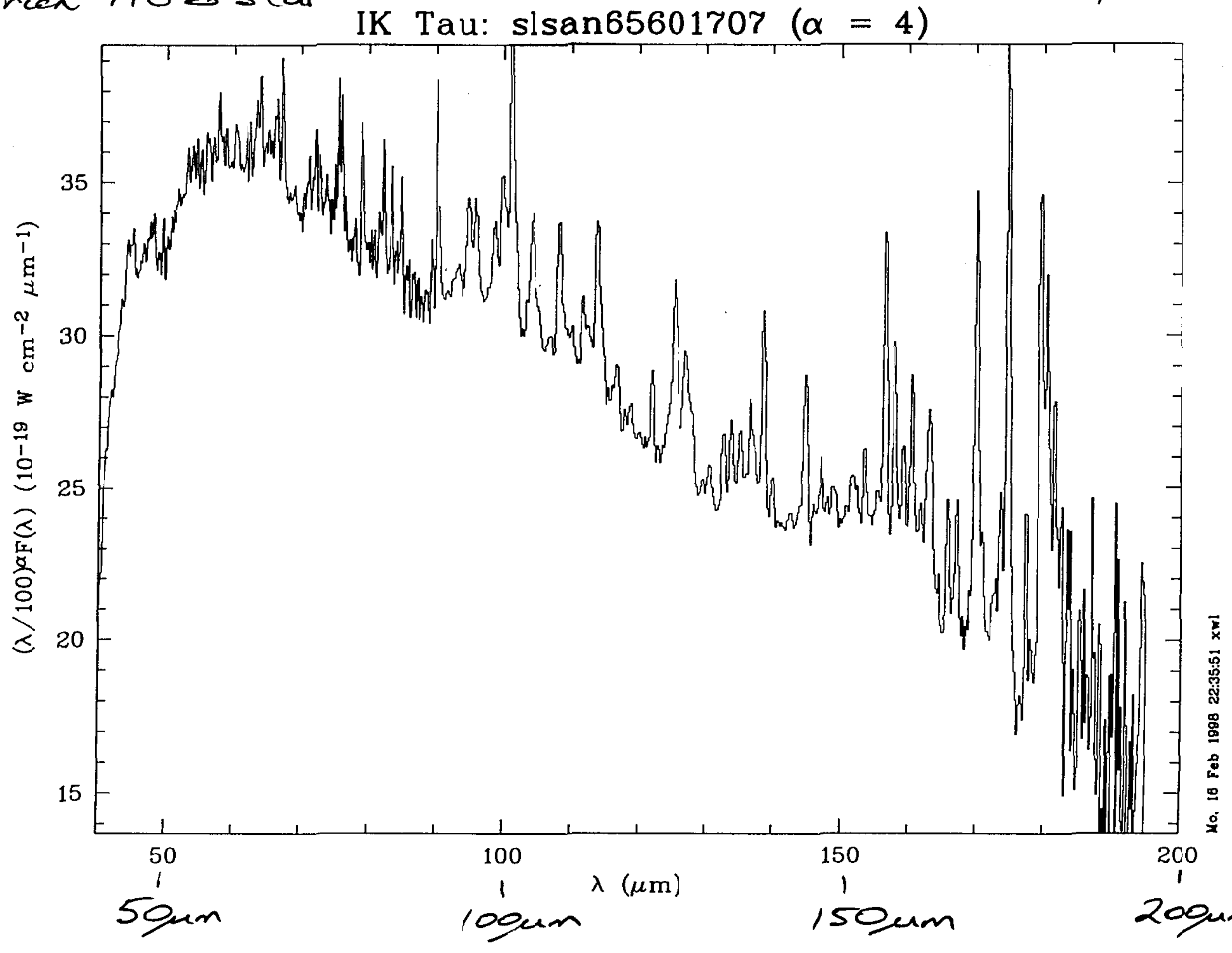
⇒ Magellanic Clouds (+ Bulge)

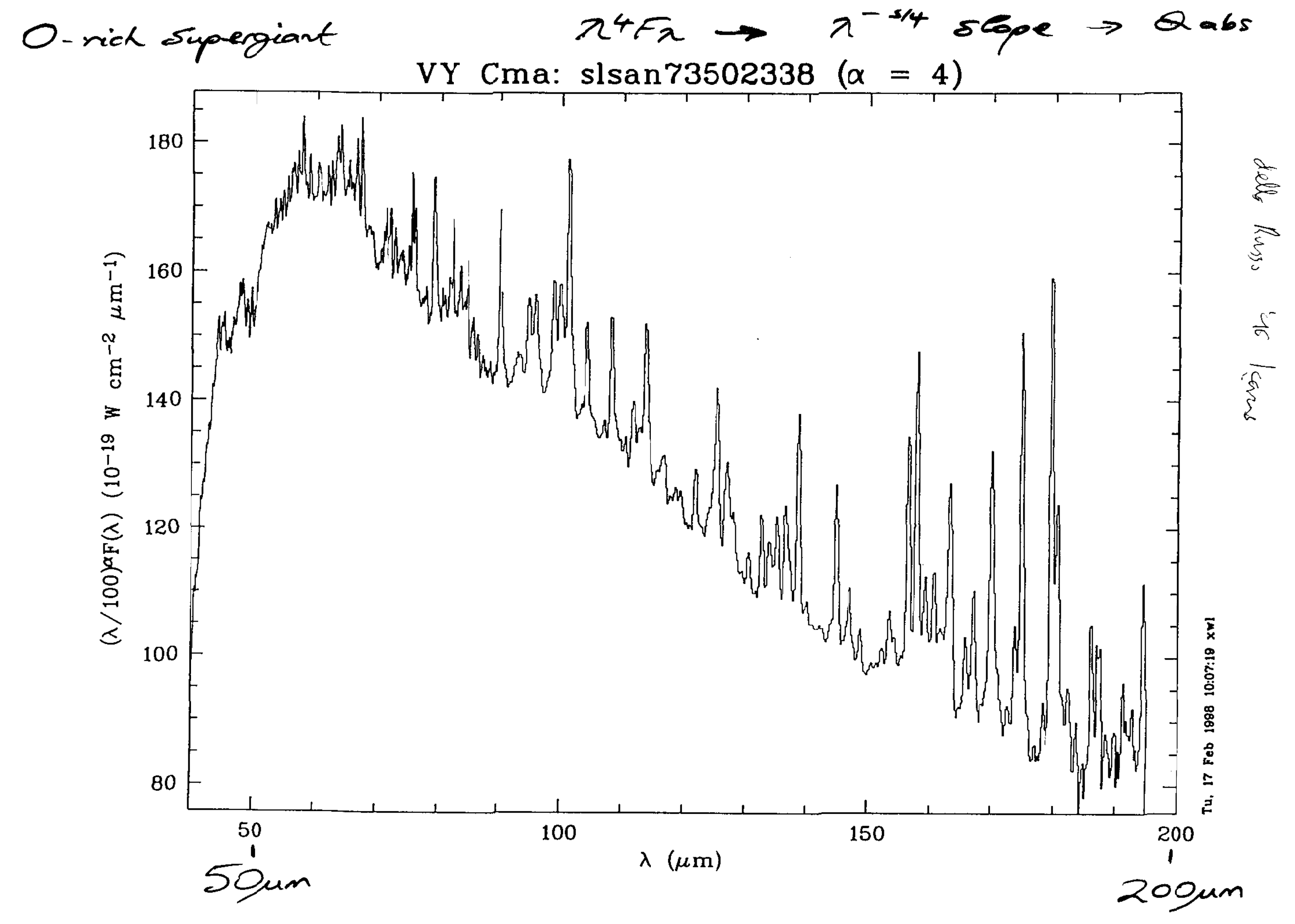
Too faint and too many for HIFI
to carry out complete spectral
surveys of them.

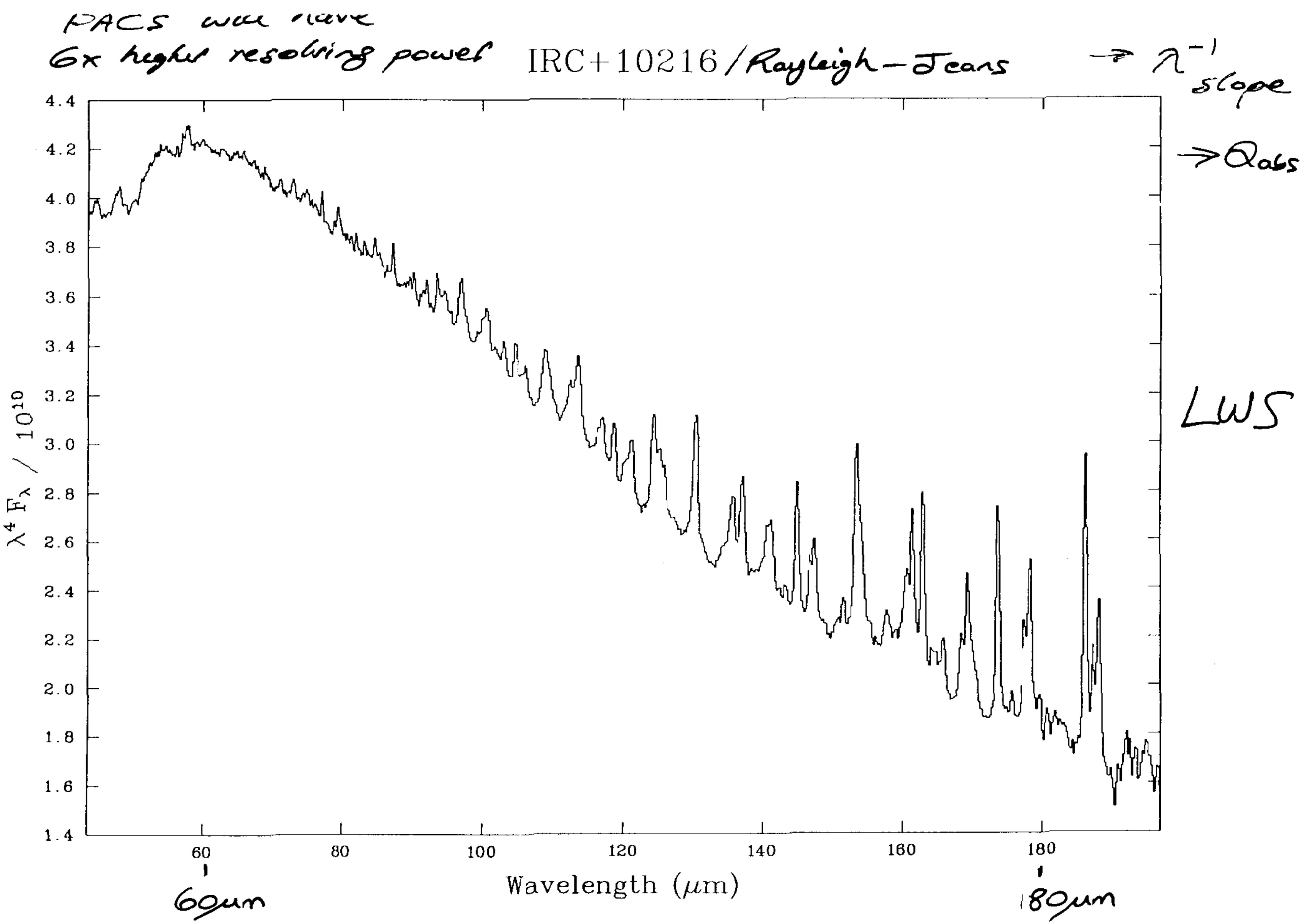
Supplemented by complete
PACS spectra from 60–210 μm.

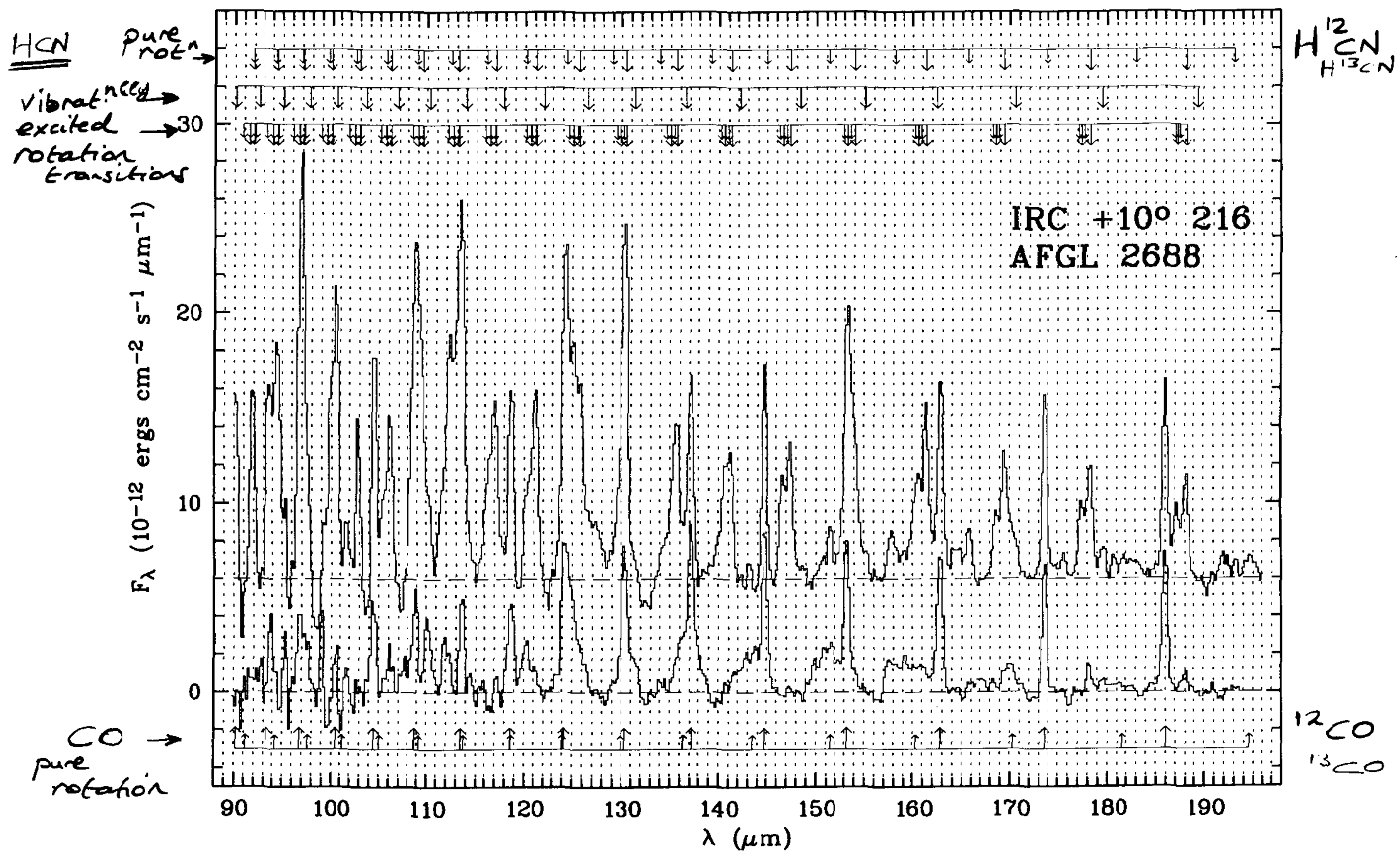
Will characterise both dust and gas
as a function of metallicity and
luminosity ⇒ enrichment rates
for galaxies in heavy elements
and dust.

O-rich AGB star $\lambda^4 F_\lambda \rightarrow \lambda^{-0.6}$ slope → Q_{abs}




O-rich supergiant
$\lambda^4 F_\lambda$ → $\lambda^{-5/4}$ slope → Qabs
VY Cma: slsan73502338 (α = 4)
(λ/100)$^\alpha$F(λ) (10-19 W cm^{-2} μm^{-1})
λ (μm)
50μm
200μm
Tu, 17 Feb 1998 10:07:19 xwl
della Russo '96 Icarus


PACS will have
6x higher resolving power
IRC+10216 / Rayleigh-Jeans
→ λ^{-1} slope
→ Qabs
LWS
$\lambda^4 F_\lambda$ / 10^{10}
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
60
80
100
120
140
160
180
Wavelength (μm)
60µm
180µm



HCN
pure rotⁿ
vibrationally excited rotation transitions
$H^{12}CN$
$H^{13}CN$
IRC +10° 216
AFGL 2688
F_λ (10^{-12} ergs cm^{-2} s^{-1} μm^{-1})
0
10
20
30
CO pure rotation
^{12}CO
^{13}CO
90
100
110
120
130
140
150
160
170
180
190
λ (μm)

(C)

Main sequence stars with dust debris disks

Large amounts of SIRTF time to be devoted to studies of dust debris disks around nearby main sequence stars.

However, the SPIRE spectral region will be untouched by SIRTF.

$\lambda \gtrsim 200\mu m$ samples the coolest, most extended and (often) most massive components of these disks. SPIRE cannot spatially resolve these disks but high S/N photometric characterisation with SPIRE can enable the disk mass distribution to be determined

+ Combine with ALMA images at $\lambda \geq 800\mu m$

Gas clearing as a function of age: Use FTS + PACS to measure [CI] 369μm + 609μm and [CII] 158μm

STUDIES OF THE INTERSTELLAR MEDIUM WITH SPIRE

EVOLUTION OF LARGE DUST GRAINS
FROM CIRRUS TO DENSE CORES } PHOTOMETER

ACCRETION COAGULATION, FRAGMENTATION

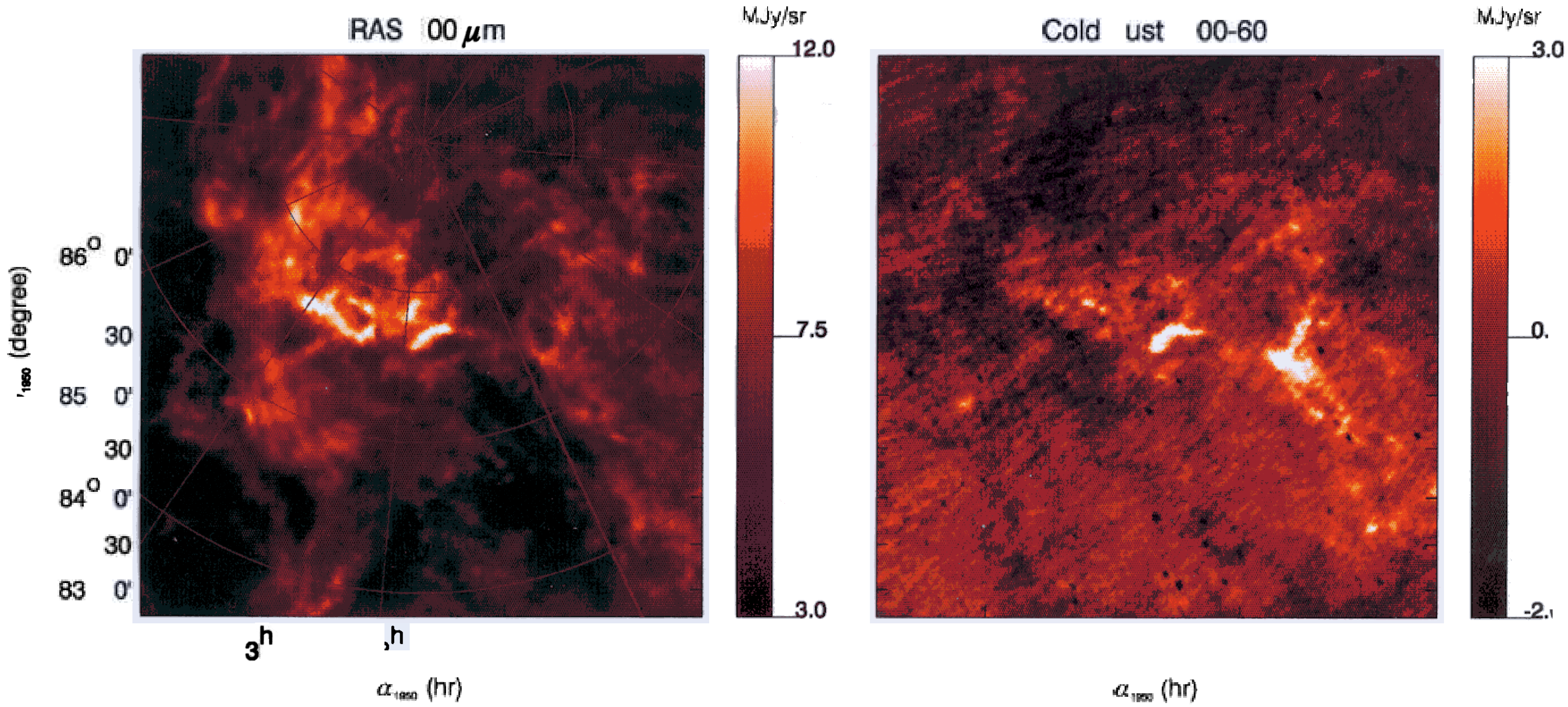
~ density structure of ISM
Excitation conditions
TURBULENT MOTIONS

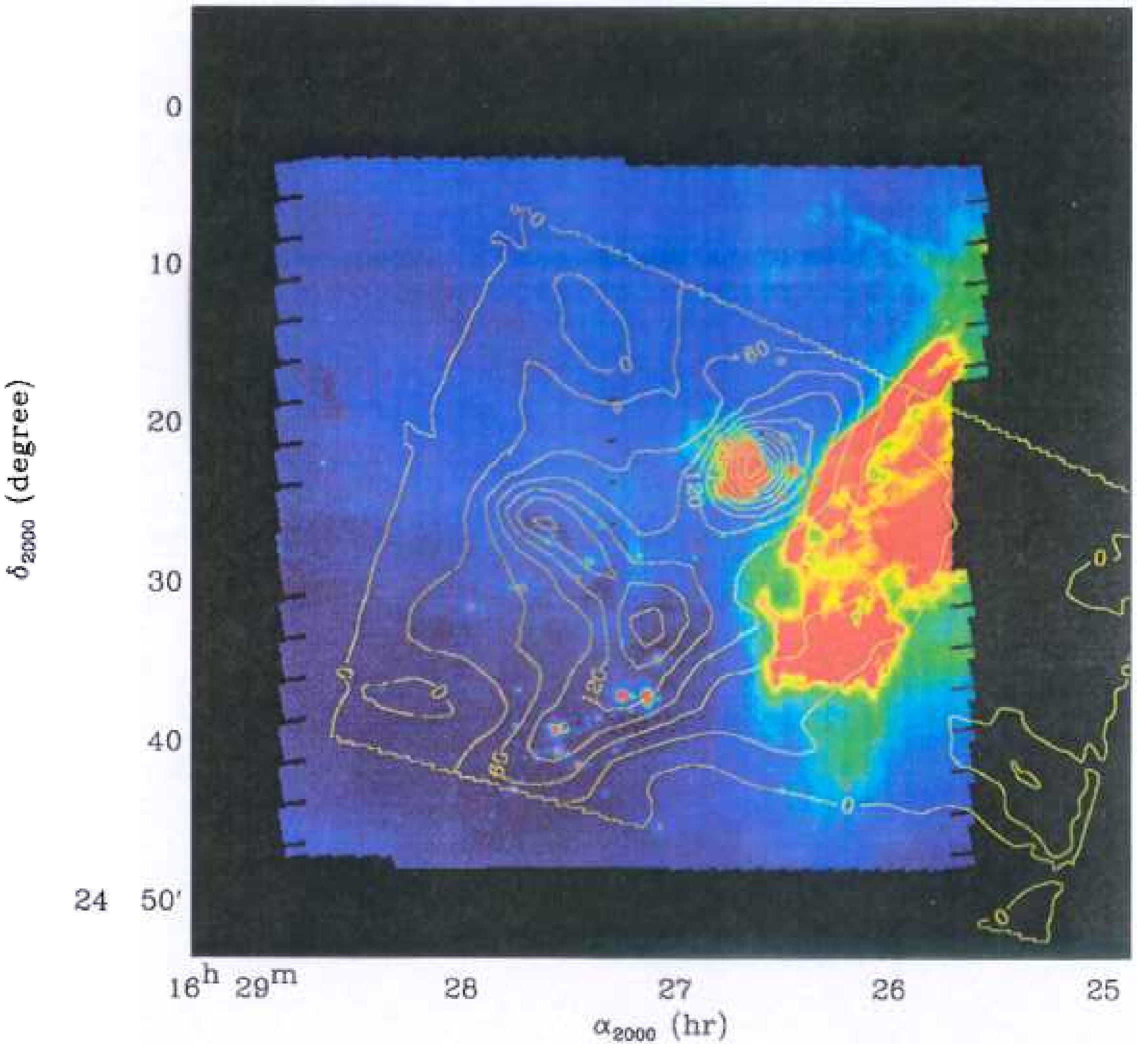
GAS PHASE PROPERTIES
SED OF DUST CONTINUUM } FTS

TEMPERATURE, DENSITY EXCITATION
CHEMISTRY

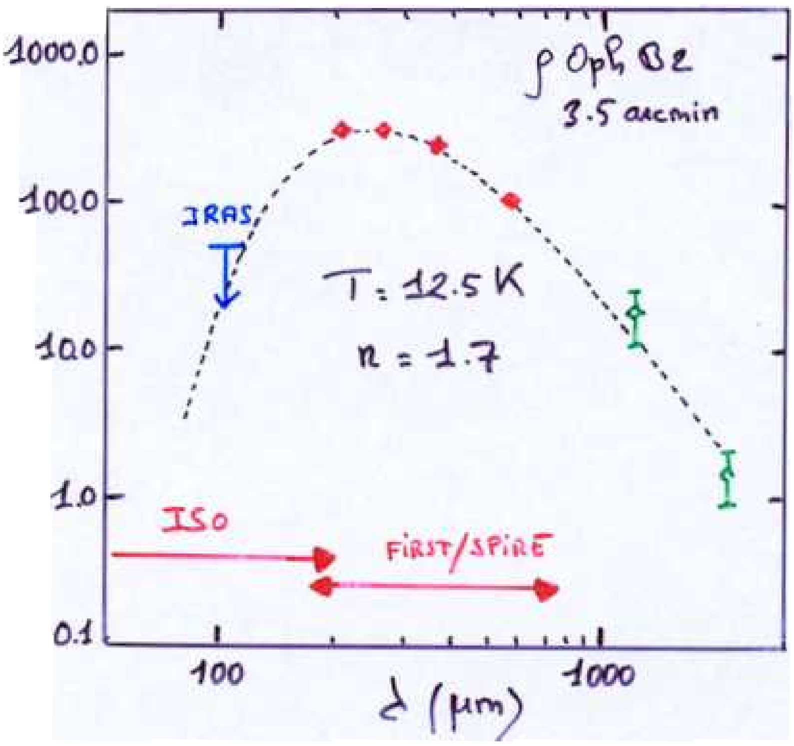
→ GAS DUST COUPLING

THE ? LA i C RRU CLOUD

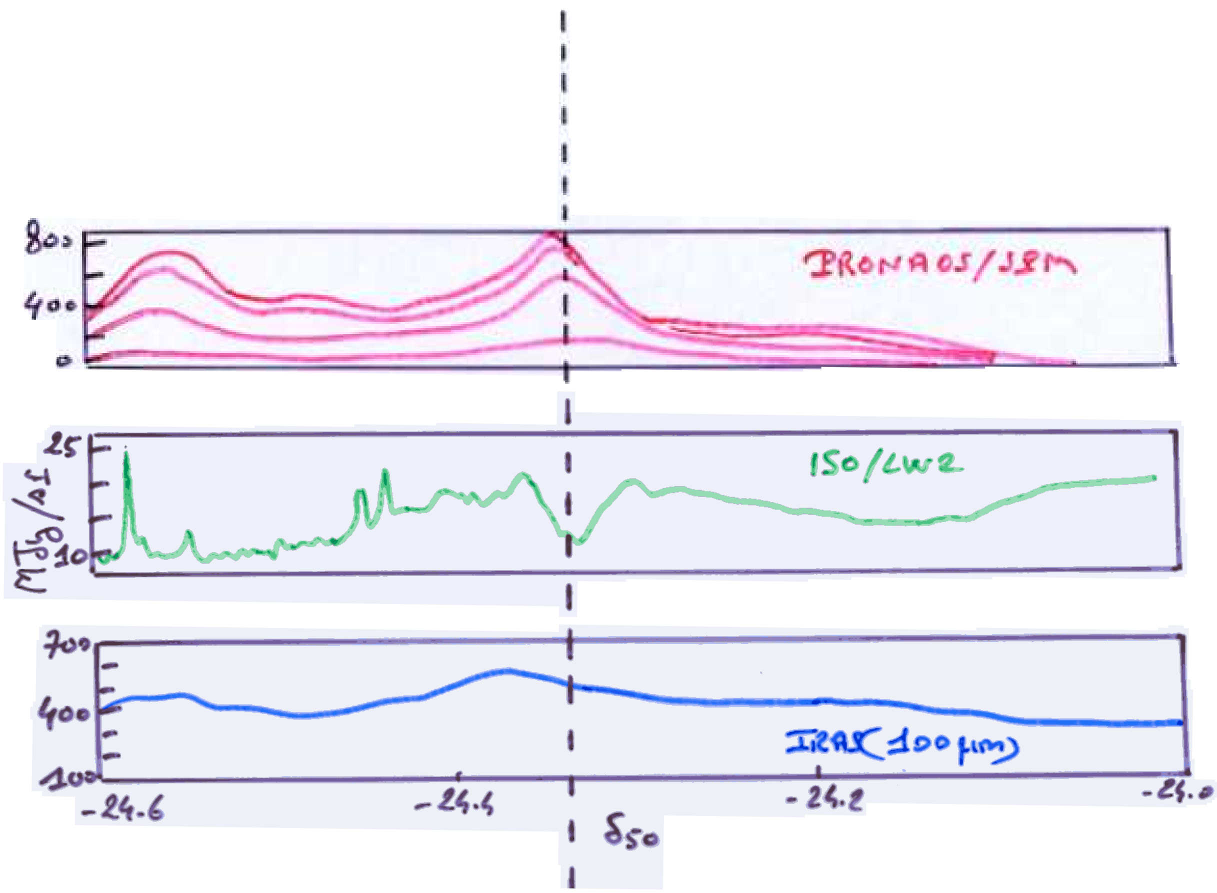




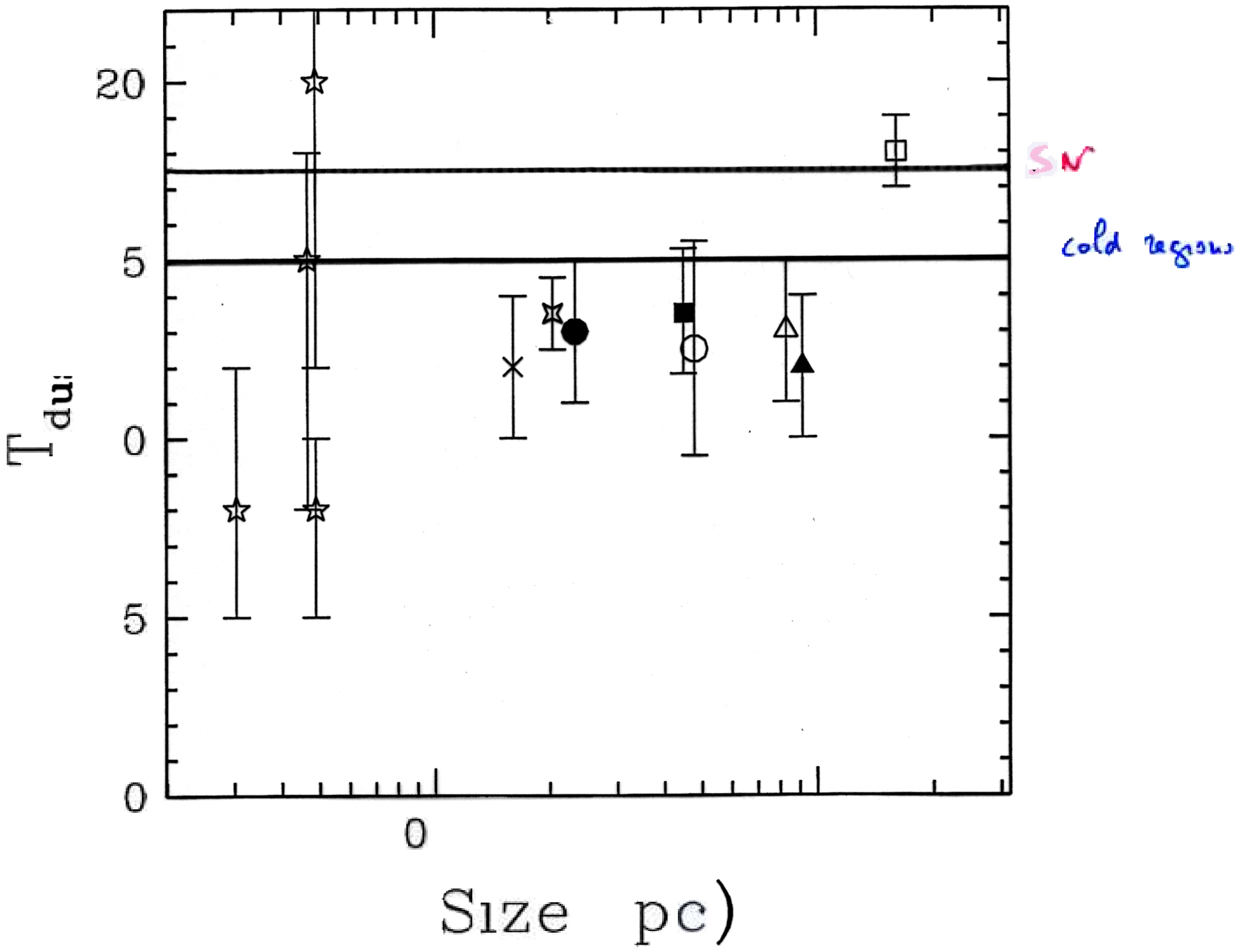
IR NAOS
Band 4   570 µm
torcelli Sena Lamane t al



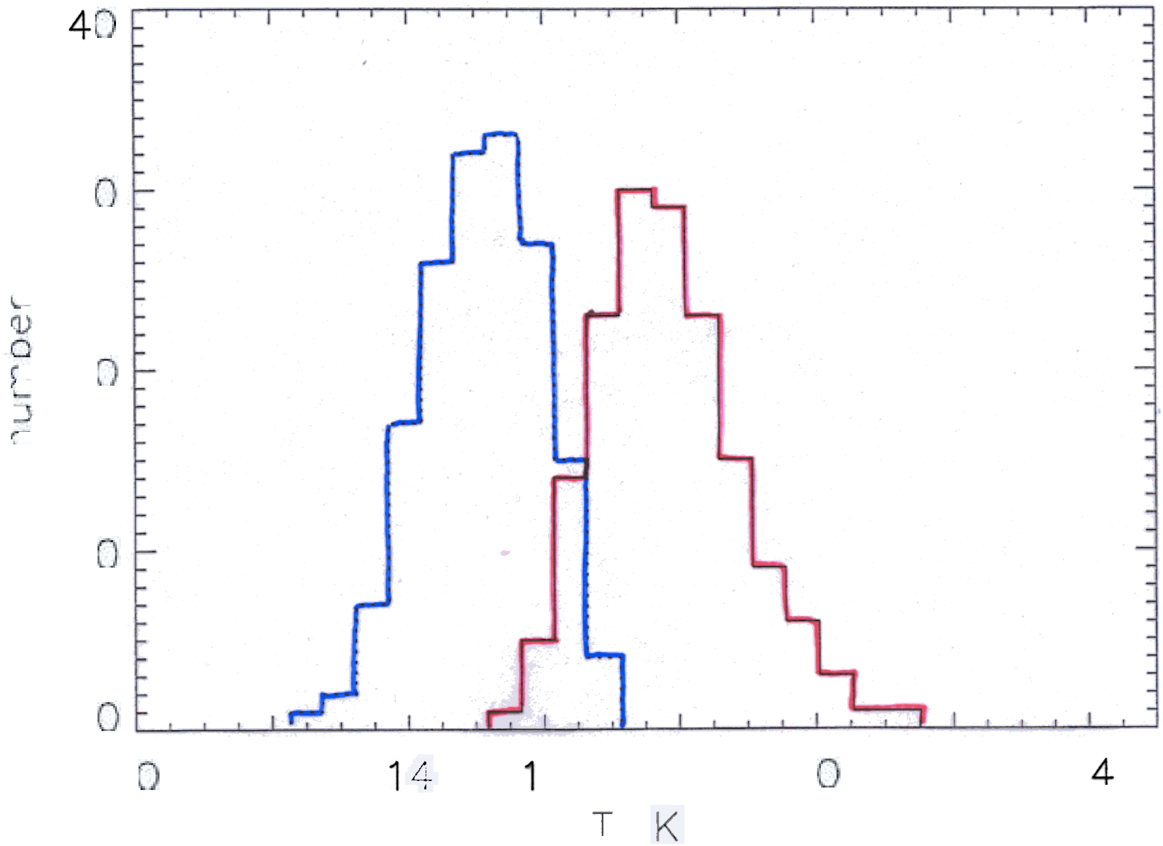
$$\langle \tau \rangle_{567\mu m} = 3.97\ 10^{-3}$$
$$\downarrow$$
$$\langle N_H \rangle \sim 5.8\ 10^{22}\ cm^{-2}$$



emperature of dense cores
clouds and globules as function
of linear size



R ...umeyo (1999)



d 5K — ffu ...mon

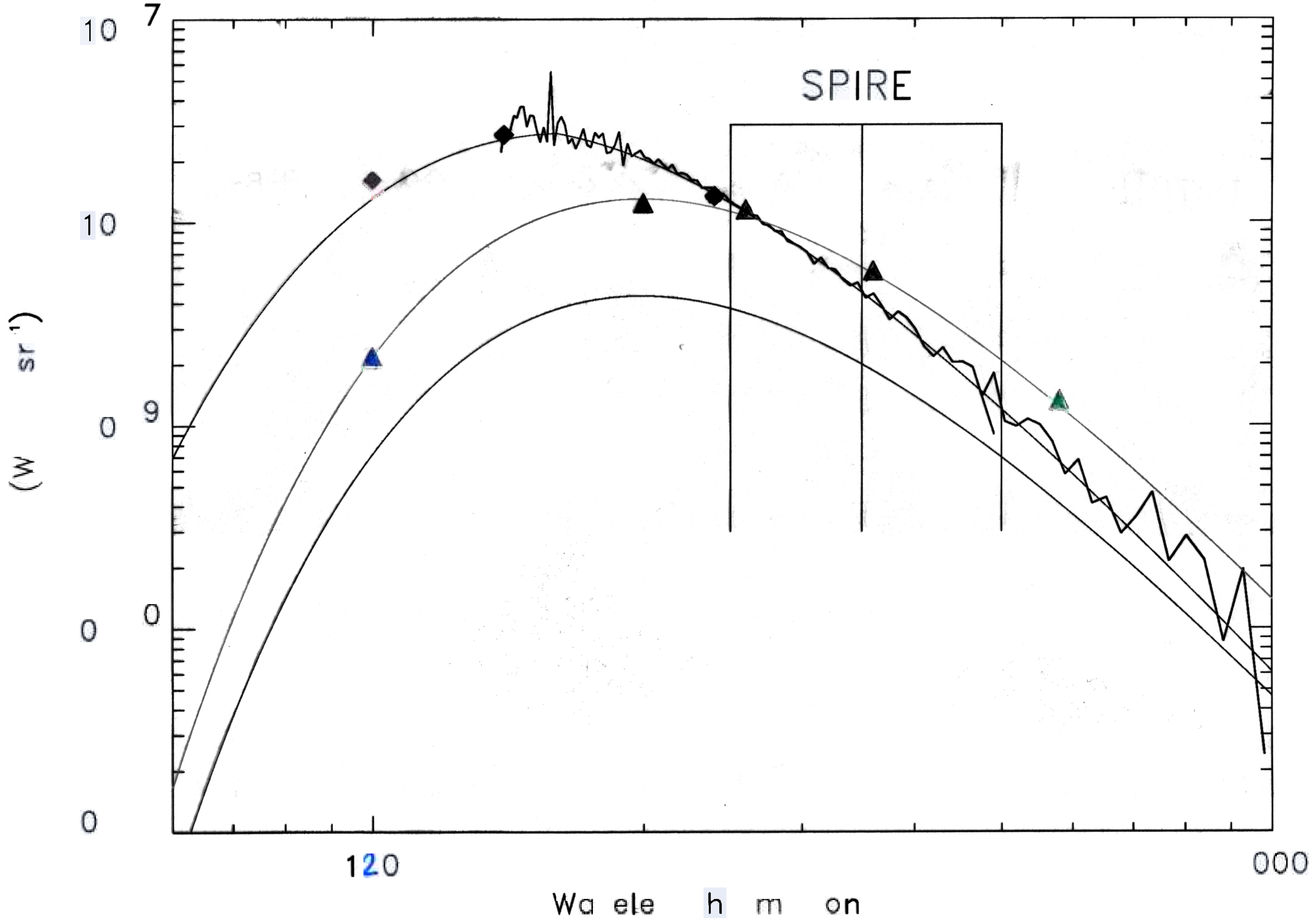
6 im deficit — d 1

gio

Lagache et al

CTRAL ENERGY DISTRIBUTION FOR A CIRRUS

PRONAOS TAURUS (Av= 4m g) dun Tdust 1 K



D with 1 K + m ss d ffu d m → COAGULAT ON PROCES

HERSCHEL/FIRST = 80 μm ⟶ 700 μm

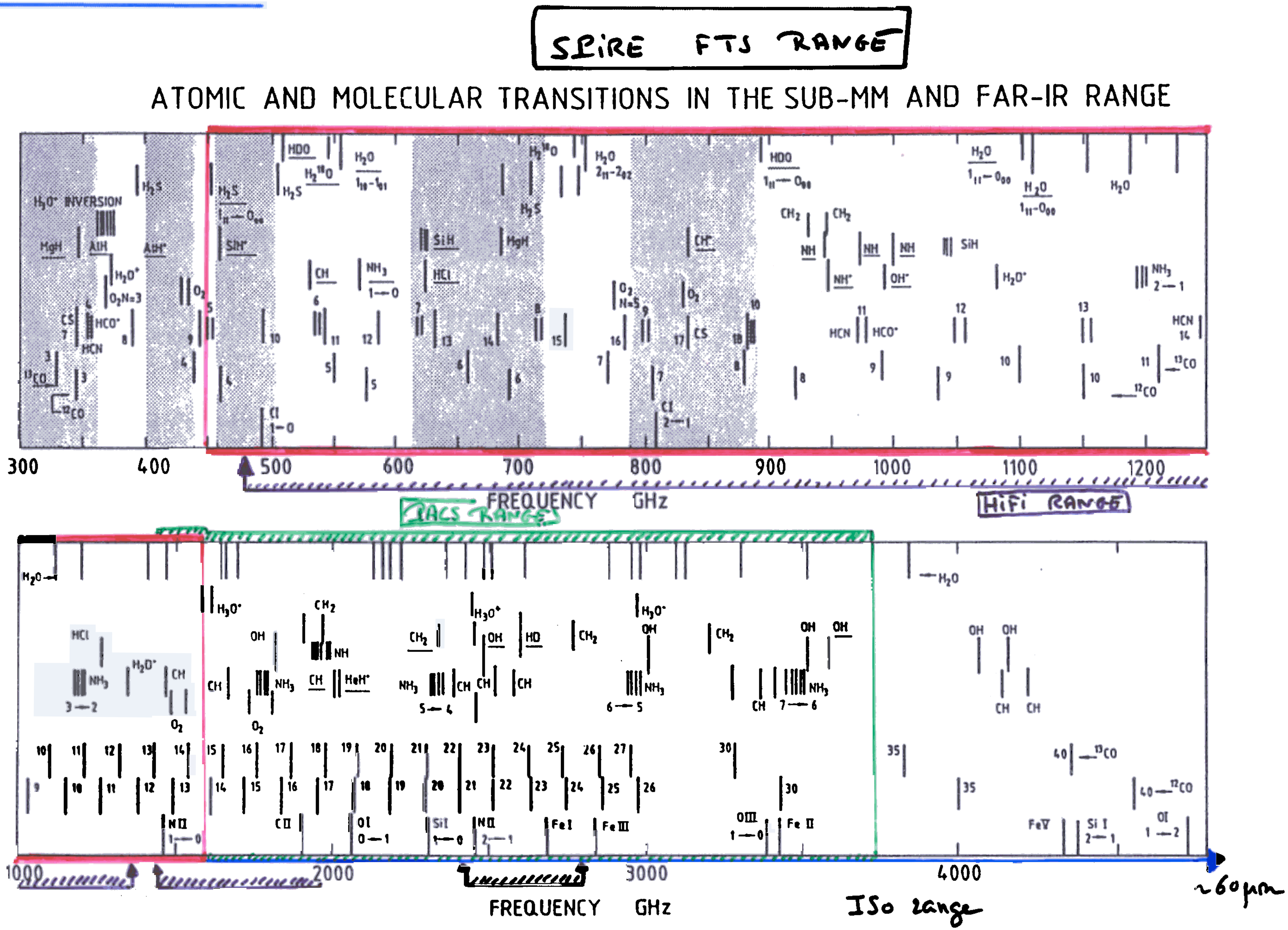
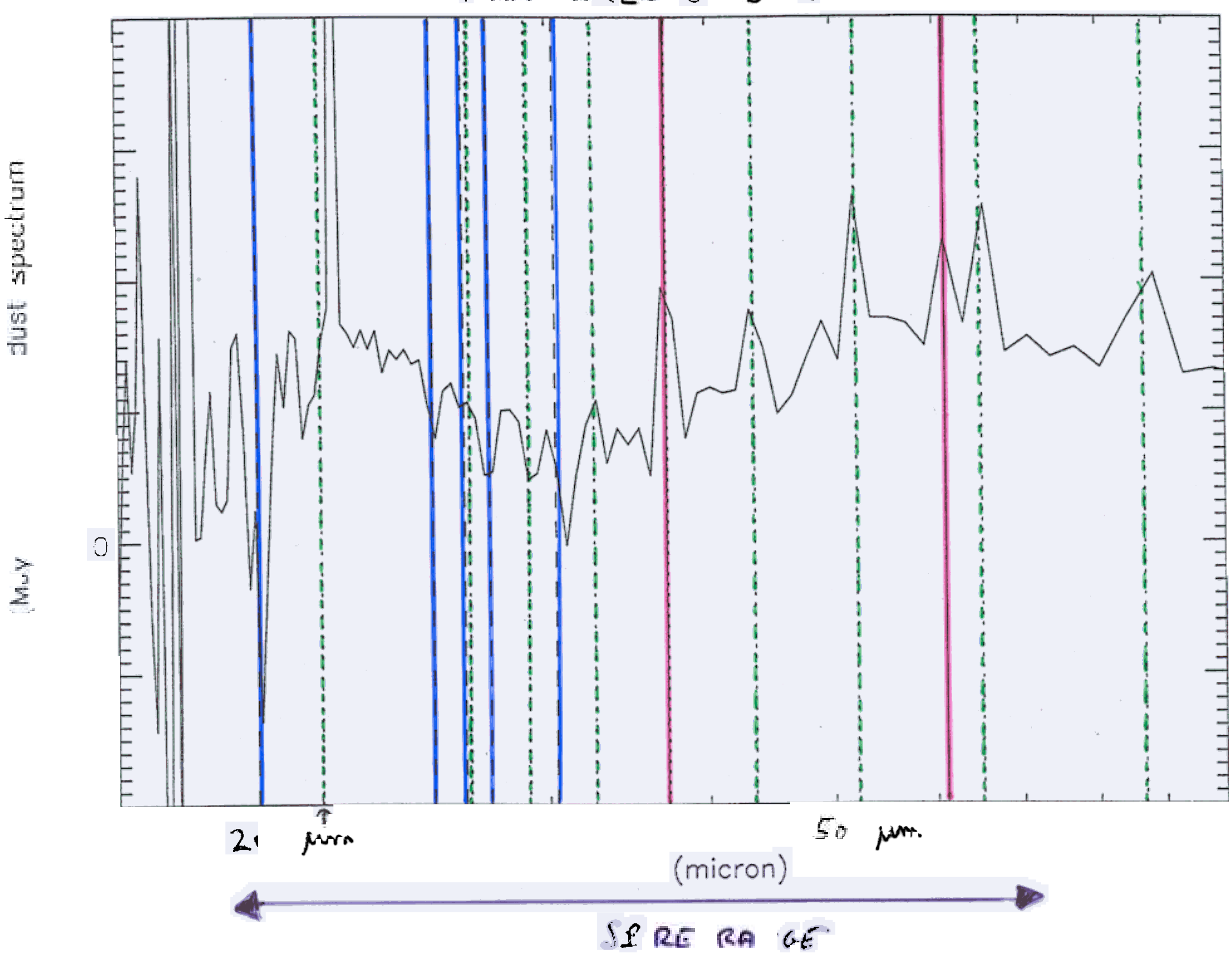


Fig. 1. Atomic and molecular transitions in the 60 μm to 1 mm range. The shaded regions represent the submillimetric atmospheric windows

F'RA 0<L< 0 b <



C ..
CI
H. O

F RA 0 7 m 1 after apodi ati)

CONT NIUUM SUBTRACT D

COBE RESULTS.

LINE FLUX IN THE PLANE AND AT HIGH GALACTIC LATITUDE

LINE	GALACTIC CENTER $\lvert l \rvert < 2.5°$	INNER GALAXY $(2.5° < \lvert l \rvert < 32.5°)$	OUTER GAL. $(\lvert l \rvert > 32.5°)$	HIGH LAT $(\lvert b \rvert > 10°$
CO 1-0	1.6 ± 0.5	0.5 ± 0.3	0.2 ± 0.2	0 ± 0.01
CO 2-1	6.4 ± 0.3	2.3 ± 0.2	0.5 ± 0.1	–
CO 3-2	11.8 ± 0.5	3.8 ± 0.3	0.7 ± 0.2	–
CO 4-3	17 ± 0.6	3.4 ± 0.3	0.5 ± 0.3	–
CO 5-4	16.5 ± 1.0	2.9 ± 0.6	0.9 ± 0.5	–
CO 6-5	11.5 ± 1.6	0.5 ± 1.0	-0.2 ± 0.7	–
CO 8-7	10.8 ± 1.4	1.8 ± 0.8	0.1 ± 0.5	–
[CI] 609 μm	11 ± 0.6	5 ± 0.4	1.4 ± 0.3	–
[CI] 370 μm	11 ± 1.9	7 ± 1.0	1.4 ± 0.5	–
[CII] 158 μm	875 ± 32	1021 ± 17	254 ± 5	1.48 ± 0.0
[NII] 205 μm	97 ± 6	107 ± 3	18 ± 1	0.05 ± 0.02
[NII] 122 μm	76 ± 51	23 ± 22	2 ± 9	0.17 ± 0.1
[OI] 146 μm	29 ± 29	24 ± 13	5 ± 5	0.07 ± 0.0
CH 116 μm	149 ± 82	14 ± 34	15 ± 15	-0.05 ± 0.2

NOTE – Units are in $nW\,m^{-2}\,sr^{-1}$. Uncertainties are 1σ.

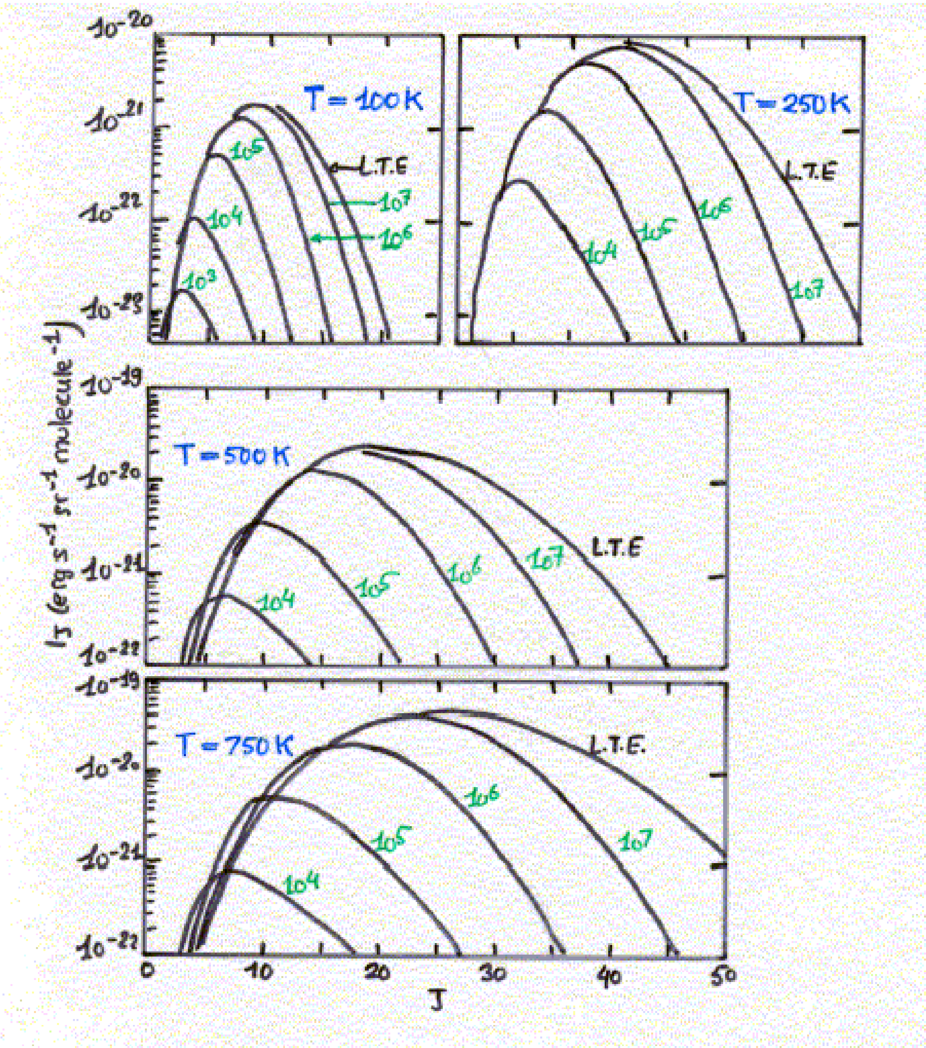
CO 9-8 289.12 μm

CO 10-9 260.24 μm

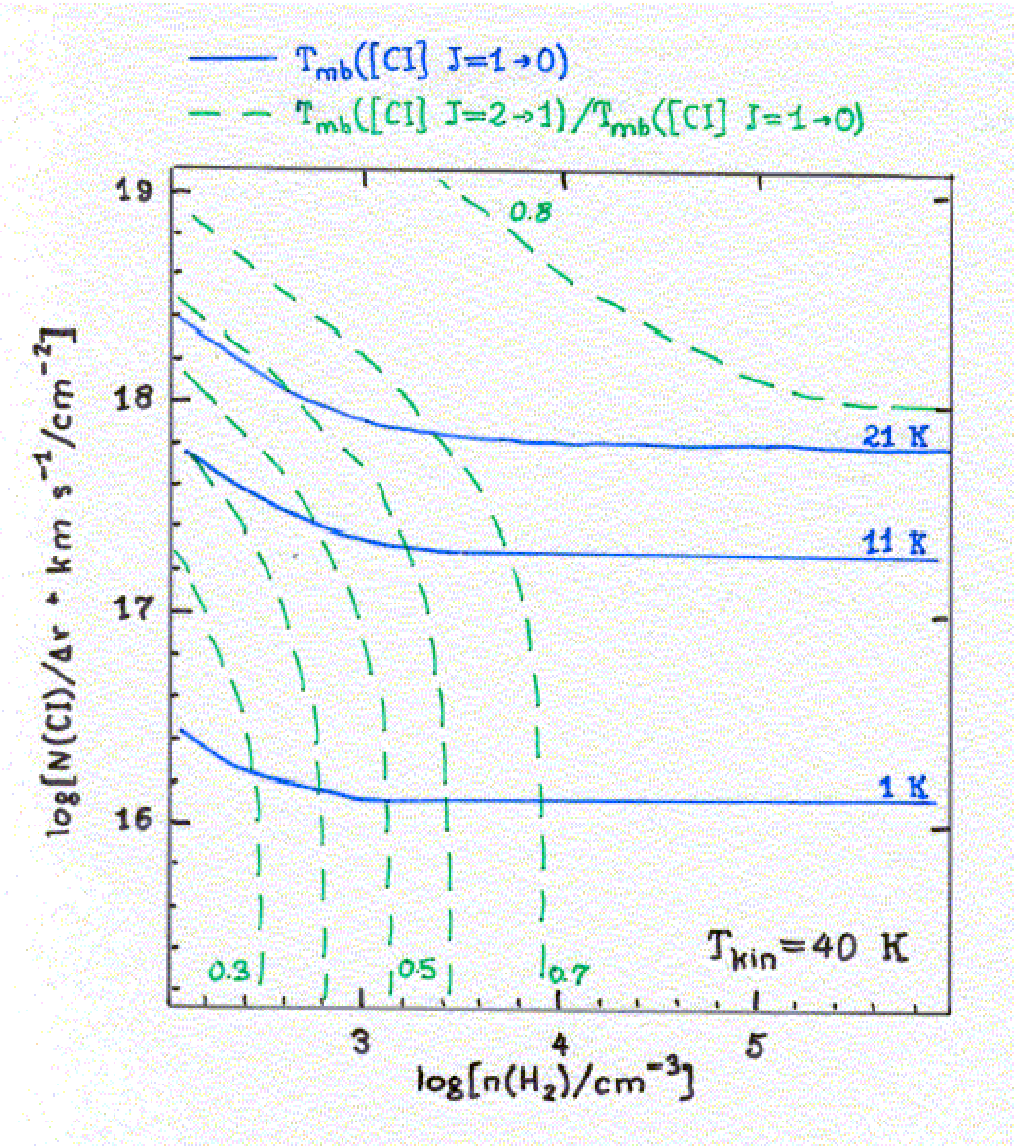
CO 11-10 236.61 μm

CO 12-11 216.93 μm

CO 13-12 200.27 μm

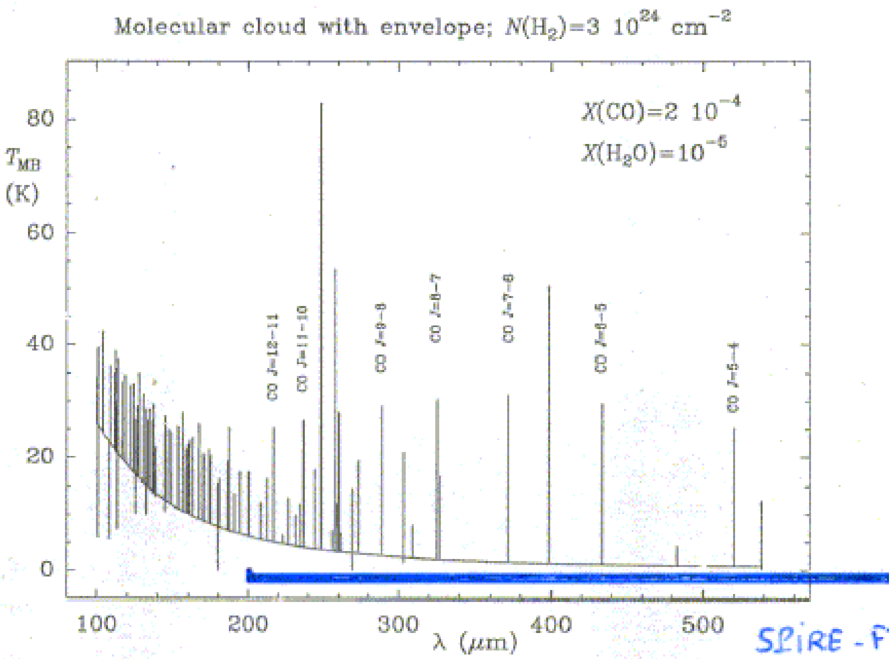


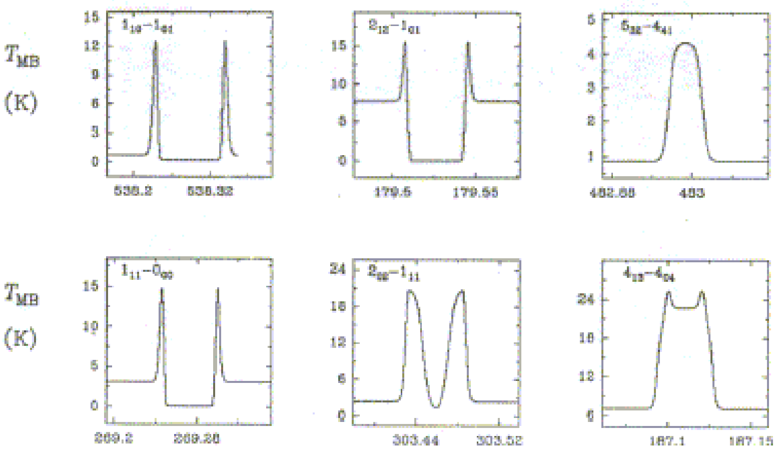
T = 100 K
L.T.E
10^7
10^6
10^5
10^4
10^3
T = 250 K
L.T.E
10^4
10^5
10^6
10^7
T = 500 K
L.T.E
10^4
10^5
10^6
10^7
T = 750 K
L.T.E.
10^4
10^5
10^6
10^7
I_J (erg s^-1 sr^-1 molecule^-1)
10^-20
10^-21
10^-22
10^-23
10^-19
0
10
20
30
40
50
J

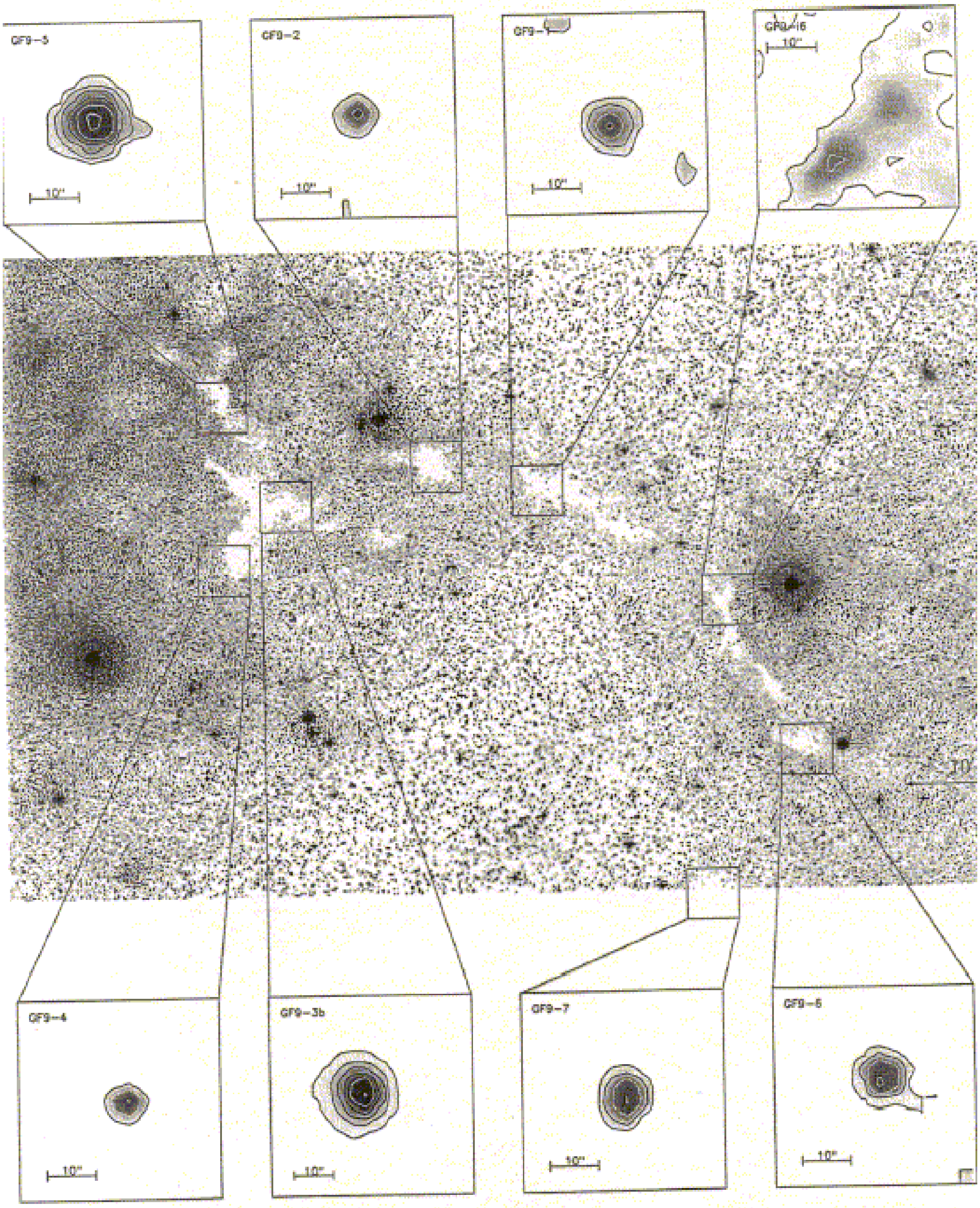


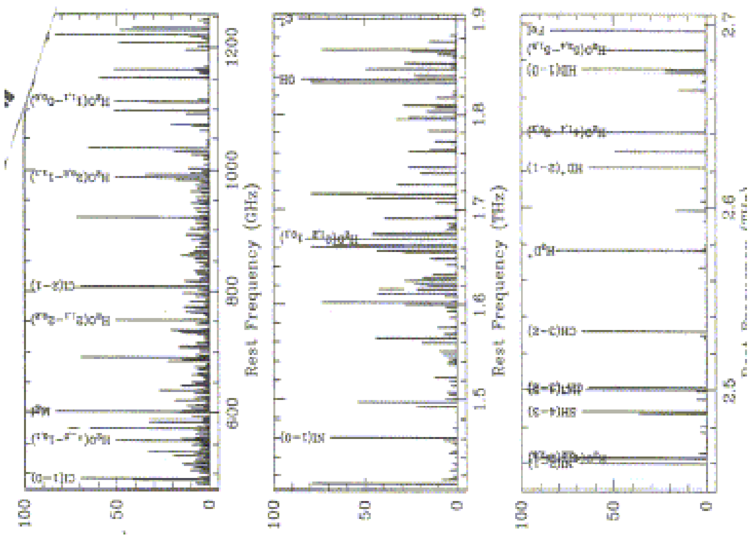
Tmb([CI] J=1→0)
Tmb([CI] J=2→1)/Tmb([CI] J=1→0)
0.8
21 K
11 K
1 K
0.3
0.5
0.7
Tkin=40 K
19
18
17
16
3
4
5
log[N(CI)/dr • km s-1/cm-2]
log[n(H2)/cm-3]

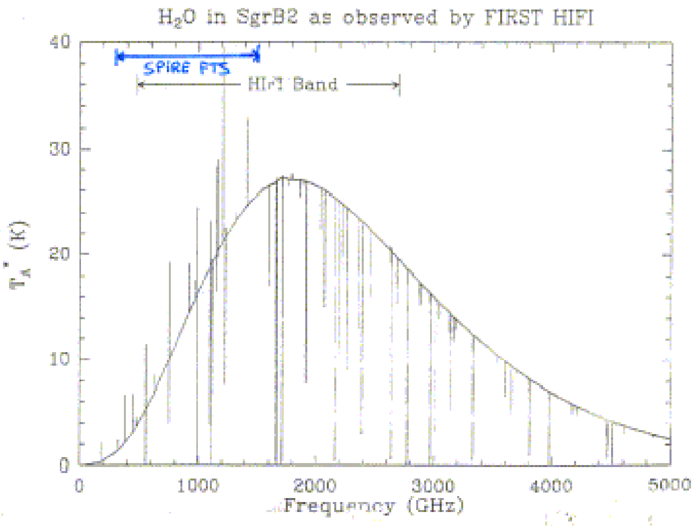
Figure 3: Model prediction for a warm molecular cloud (see text)






GF9-5
10"
GF9-2
10"
GF9-1
10"
GF9-16
10"
GF9-4
10"
GF9-3b
10"
GF9-7
10"
GF9-6
10"



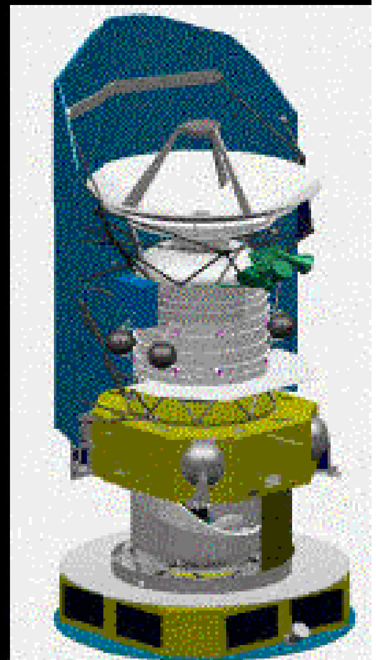


H_2O in SgrB2 as observed by FIRST HIFI
SPIRE FTS
HIFI Band
T_A^* (K)
Frequency (GHz)

AN H S O STUDY OF NEARBY STAR FORMING REGIONS

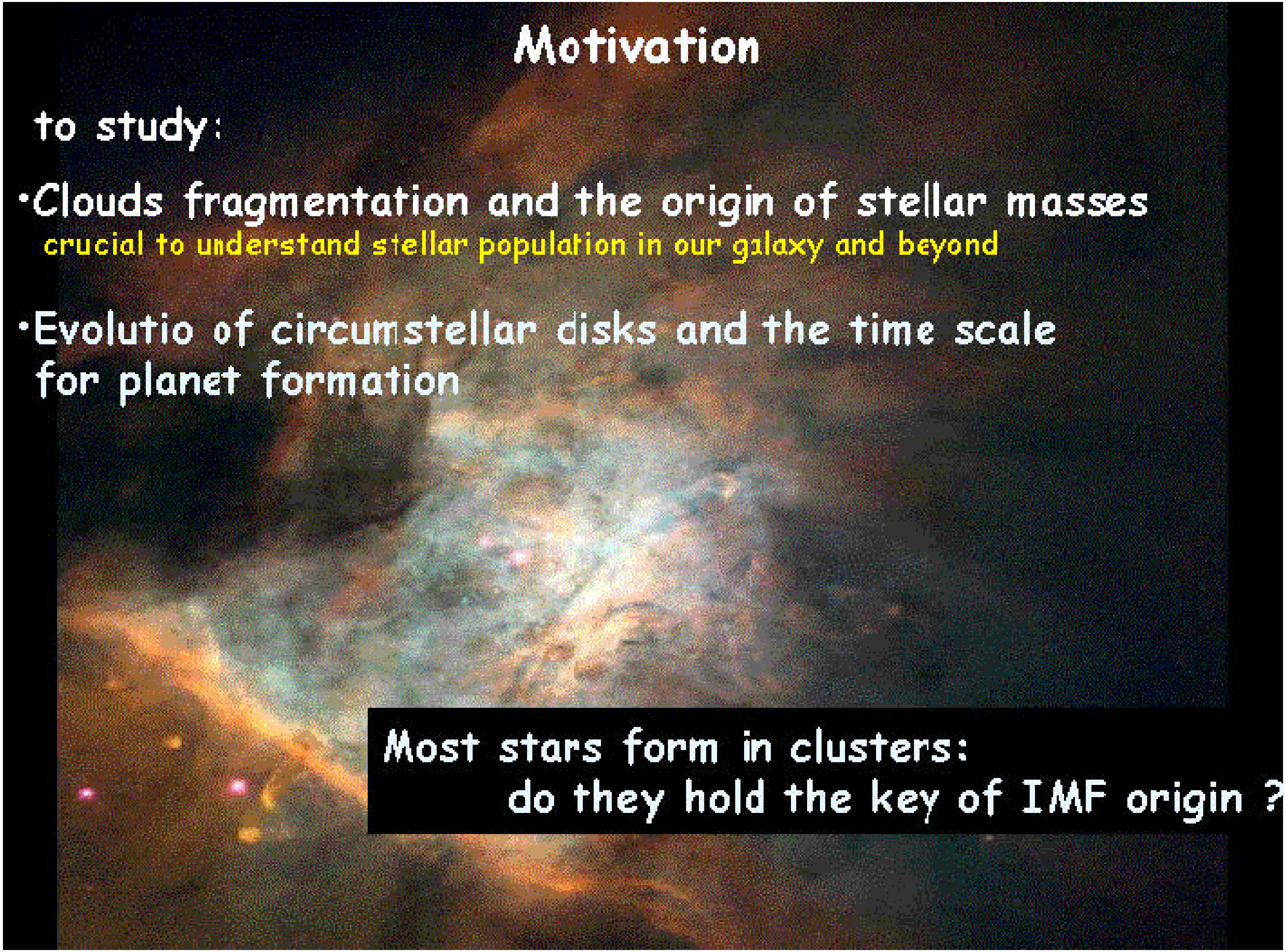
Paolo Saraceno
IFSI Rome

A survey of the known clusters and protoclusters in the nearby (< 500pc) star forming regions



- to measure the SED of individual members

- to study spectroscopically the ISM


Motivation
to study:
•Clouds fragmentation and the origin of stellar masses
crucial to understand stellar population in our galaxy and beyond
•Evolutio of circumstellar disks and the time scale for planet formation
Most stars form in clusters:
do they hold the key of IMF origin ?

CLUSTERING IN STAR FORMING REGIONS

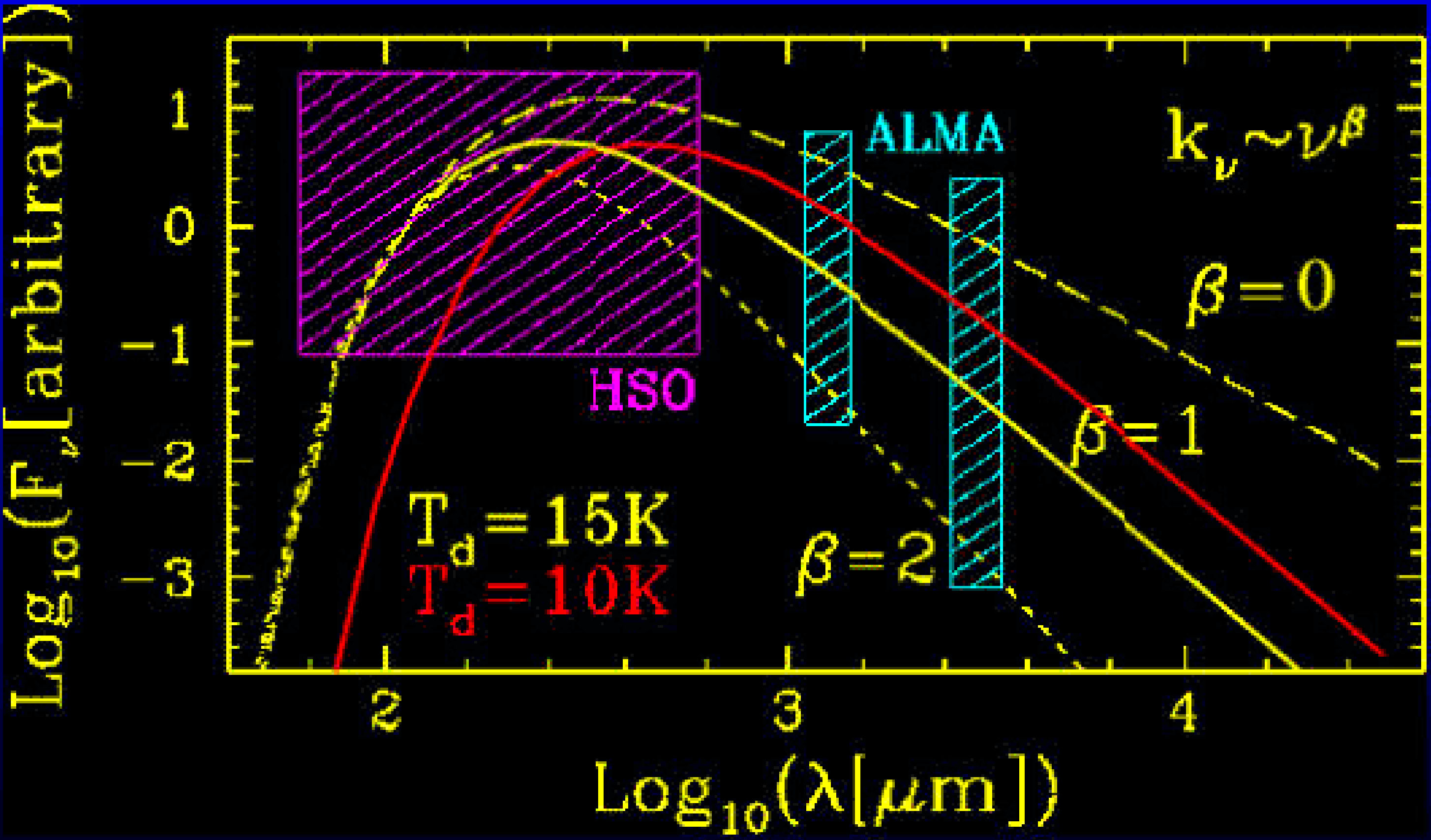
	Most Massive Stars	Mean Separation			
	$[M_\odot]$	[pc]	Taurus	Orion	Ref.
T Tauri	<2	0.3	7'.4	2'.2	Gomez, M. et al 1993, AJ, 105, 1927
Herbig Ae/Be	$2 < M_* < 10$	0.06-0.2	1'.5 – 4'.9	27" – 90"	Testi, L. et al. 1999, A&A, 342, 515
Massive stars	>10	<.04 <8000 AU	60"	18"	Herbig, G.H. and Terndrup, D.M. 1986, ApJ, 307, 609

Close to the dimension of the protostellar envelopes

Below 500pc HERSCHEL will resolve single condensations

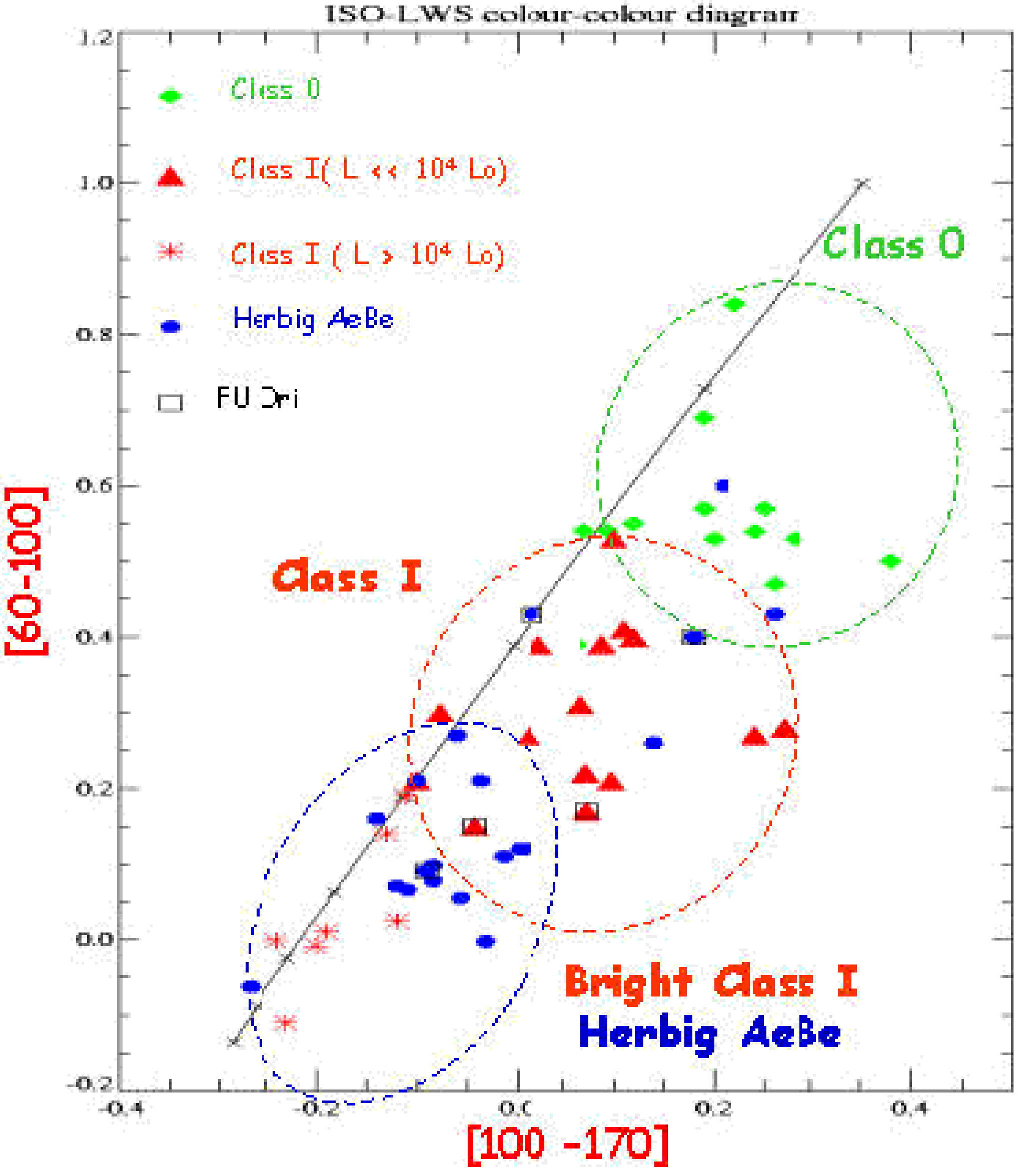
Why Herschel ?

- Wavelength Coverage: 60-600 μm
- Sensitivity: 0.001 Msun, 1hr, 5σ, T>20K at 310pc
- Angular resolution: 7 arcsec at $100\mu m$

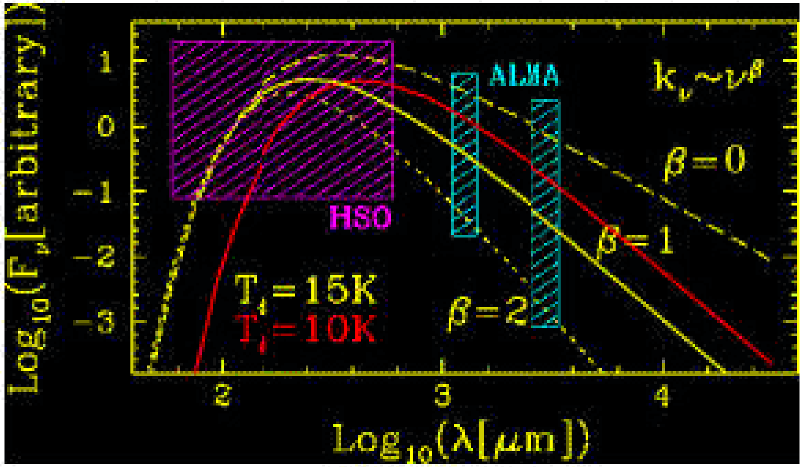


ISO LWS colour colour diagram

(Pezzuto et al. 1998, 2001)



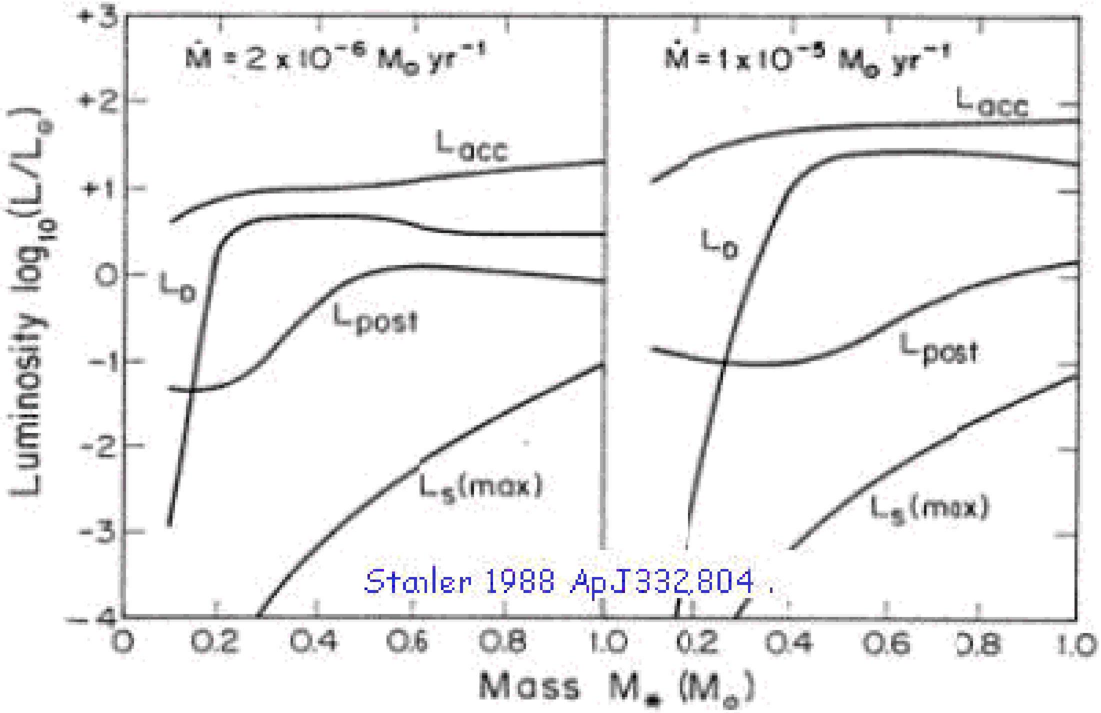
The FIR capability of discriminating among the different evolutionary phases

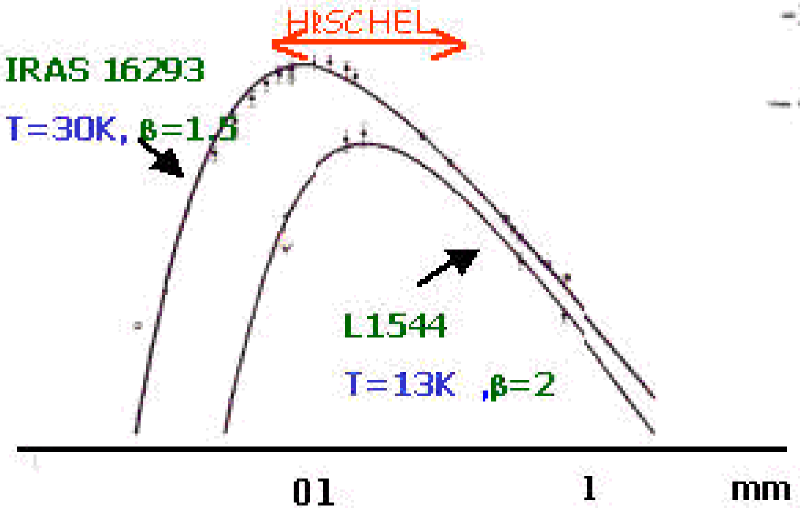


HERSCHEL: unique in detecting the low end of IMF during the accretion phase

accreting objects are luminous

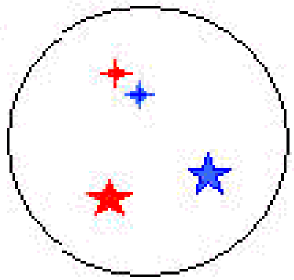
and peak in the HERSCHEL range





for studying clusters sensitivity is not the limiting factor, but sources confusion

Stars in different evolutionary stages inside the same beam

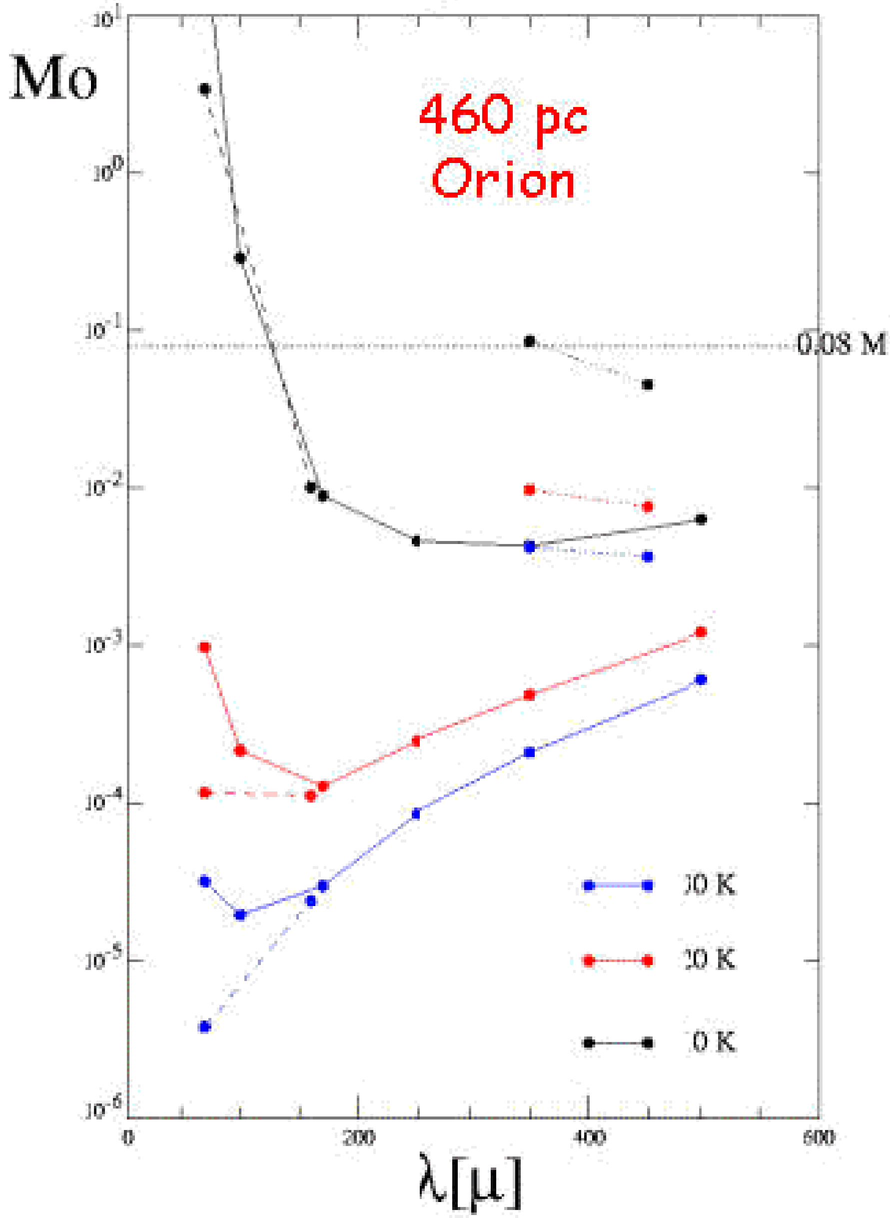


HERSCHEL: unique in detecting **pre-stellar condensations**

$Mo = F_\lambda \, k \, D^2/B(\lambda/T)$

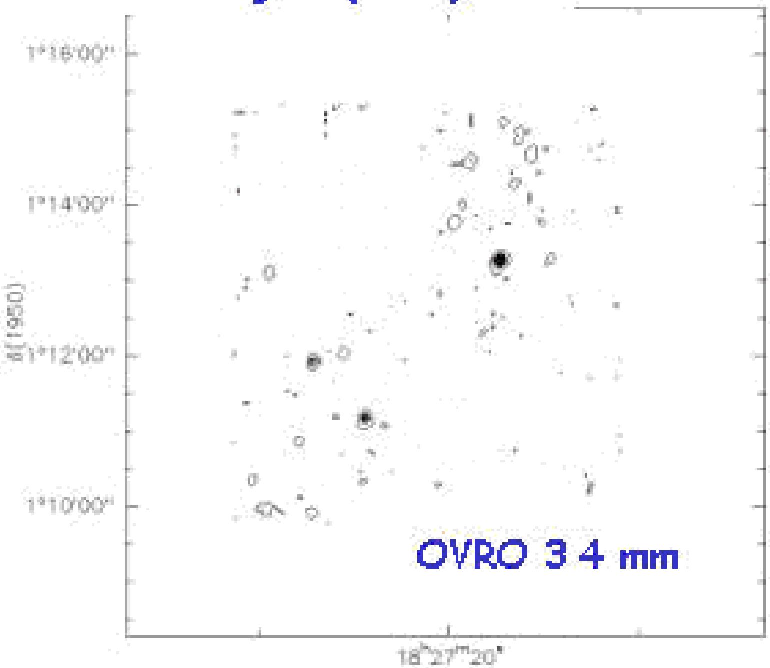
$K = 0.1(250/\lambda)$ $[cm^{-2}\ g^{-1}]$

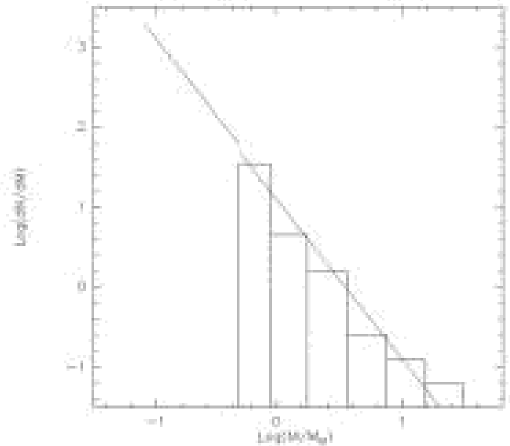
HERSCHEL: dust mass detectable 5σ 1h



- Testi & Sargent (1998)

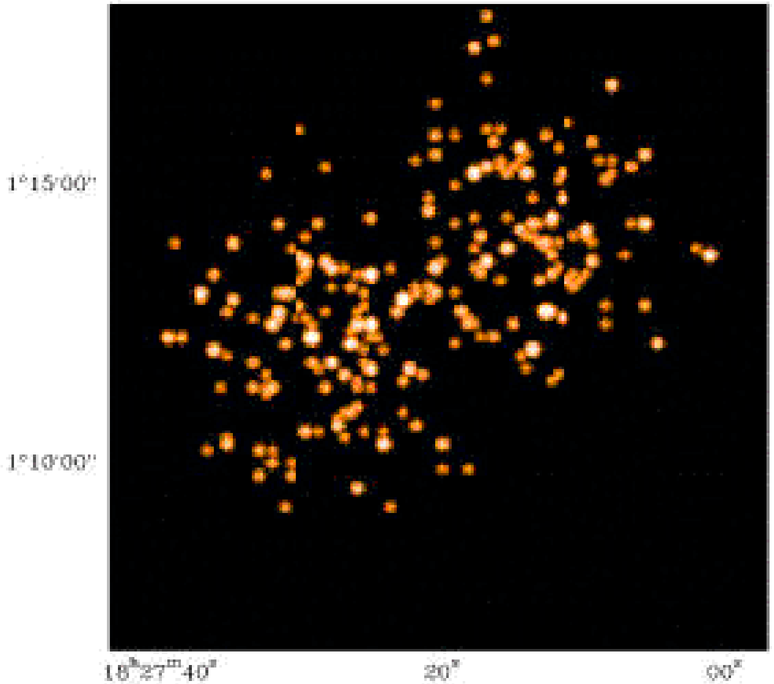
Serpens core

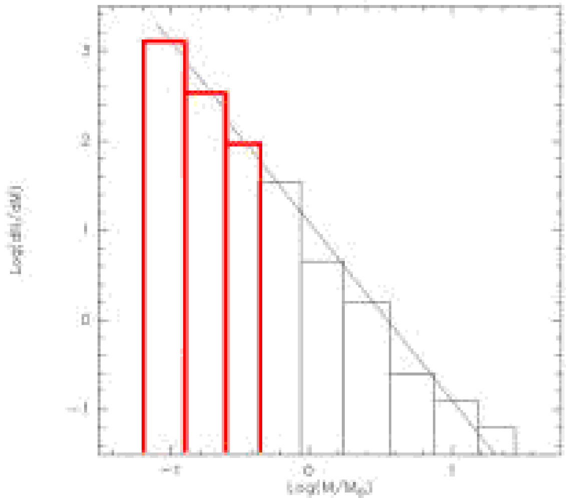




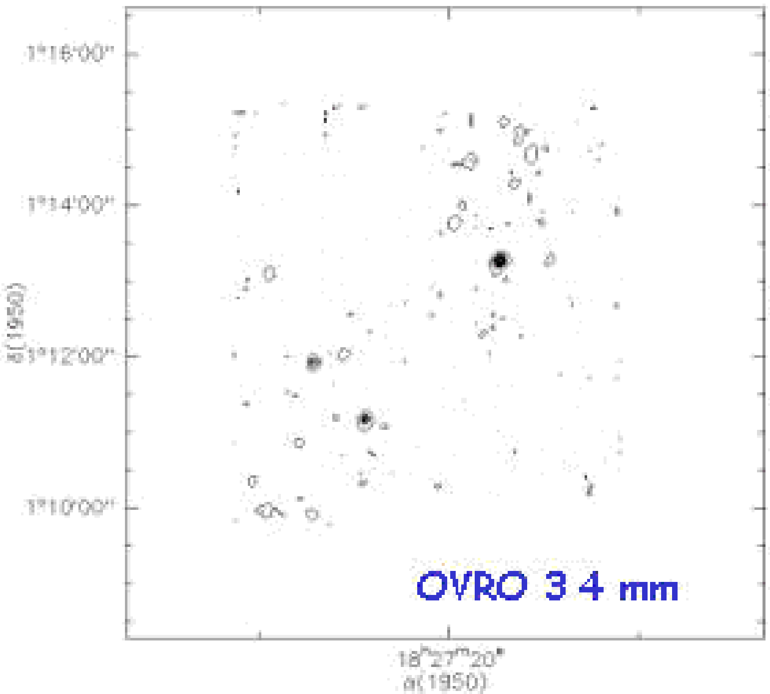
PACS 100 μm simulation

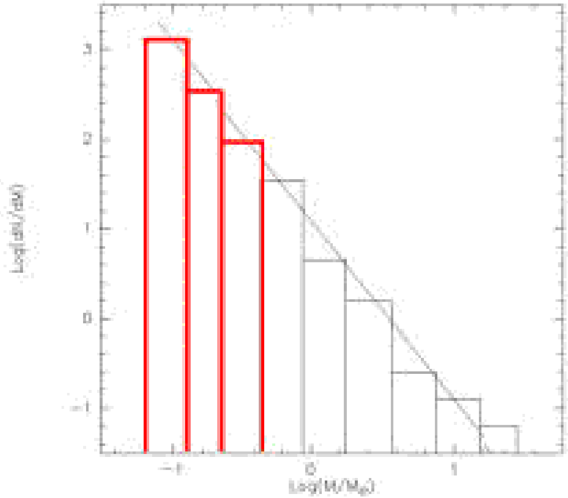
50 mJy (0.02 M⊙)

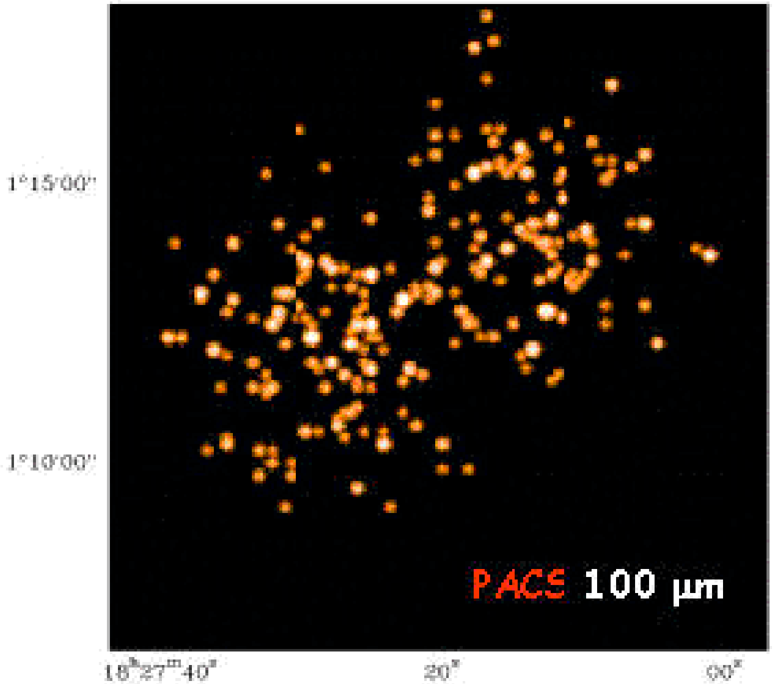




Serpens core

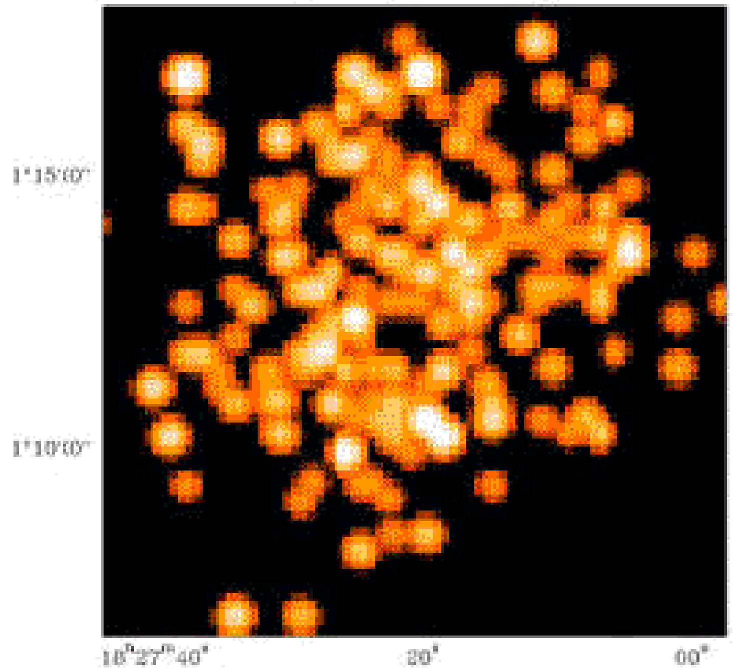


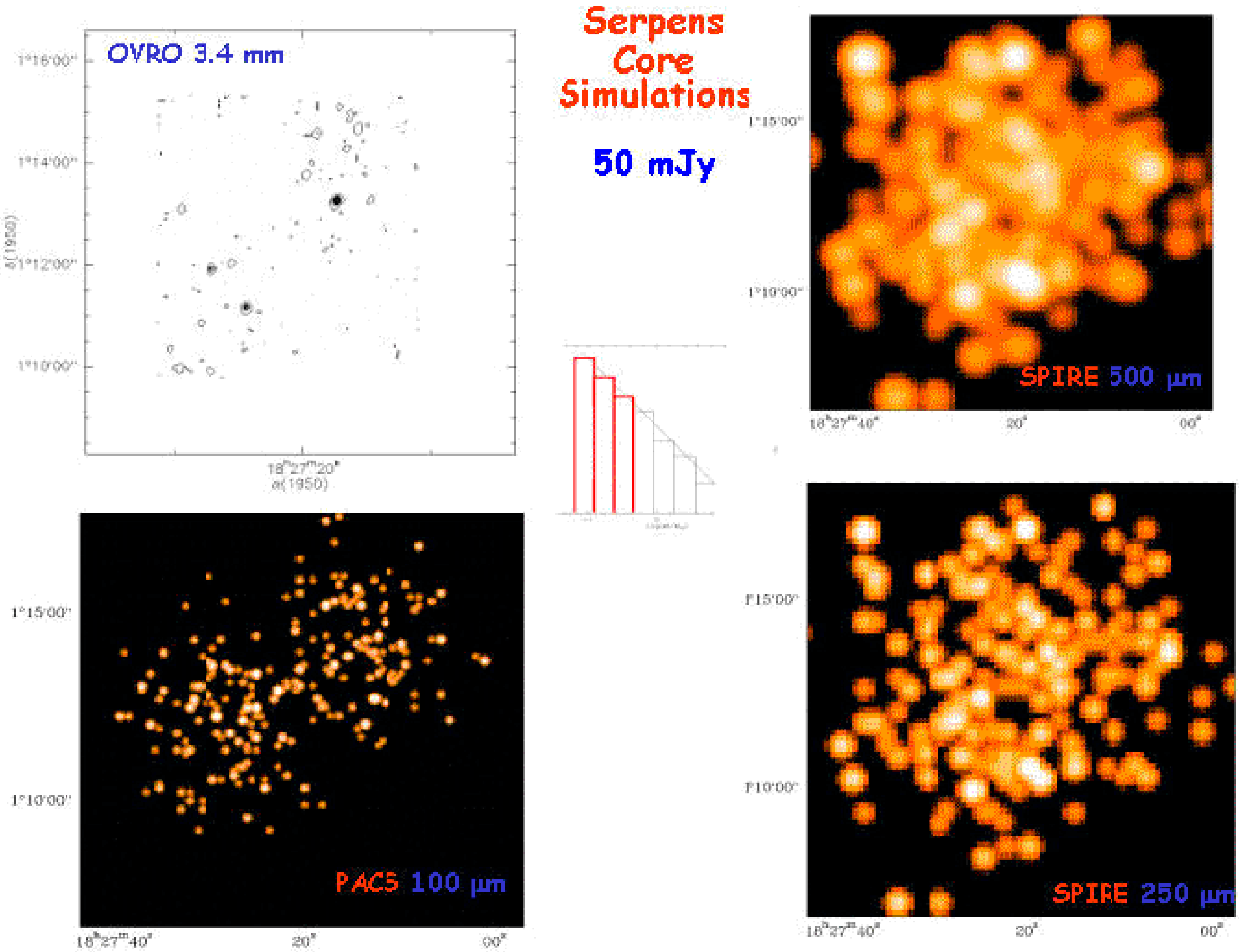


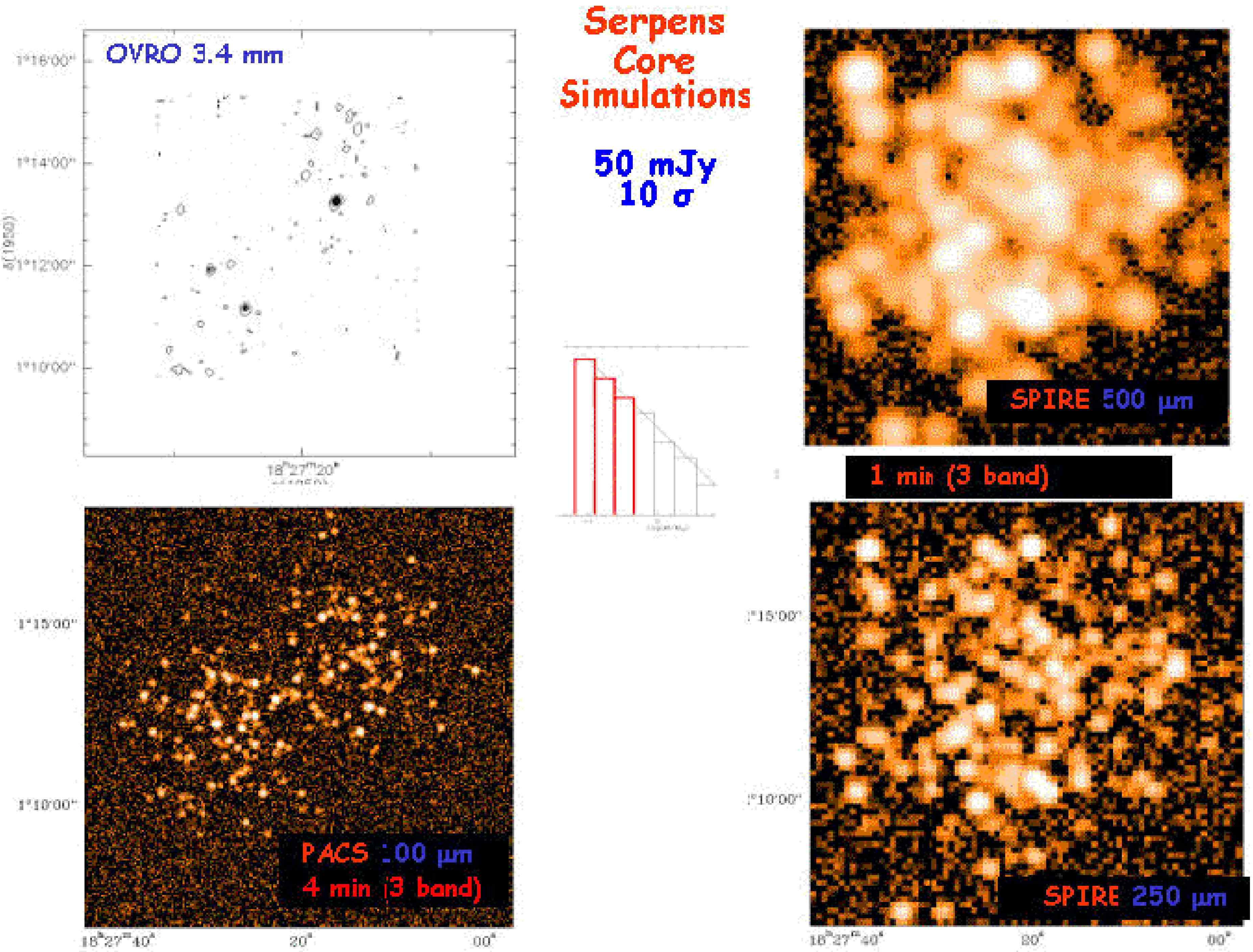


SPIRE 250 µm

50 mJy (0.005 $M_{\odot}$)




Serpens
Core
Simulations
50 mJy
OVRO 3.4 mm
1°16'00"
1°14'00"
1°12'00"
1°10'00"
δ(1950)
18h27m20s
α(1950)
SPIRE 500 μm
1°15'00"
1°10'00"
18h27m40s
20s
00s
PACS 100 μm
1°15'00"
1°10'00"
18h27m40s
20s
00s
SPIRE 250 μm
1°15'00"
1°10'00"
18h27m40s
20s
00s



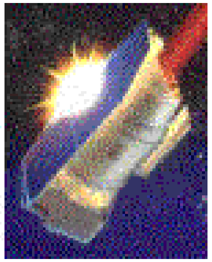
Serpens
Core
Simulations
50 mJy
10 σ
OVRO 3.4 mm
1°16'00"
1°14'00"
1°12'00"
1°10'00"
δ(1950)
18h27m20s
SPIRE 500 µm
1 min (3 band)
PACS 100 µm
4 min (3 band)
1°15'00"
1°10'00"
18h27m40s
20s
00s
SPIRE 250 µm

Possible Targets

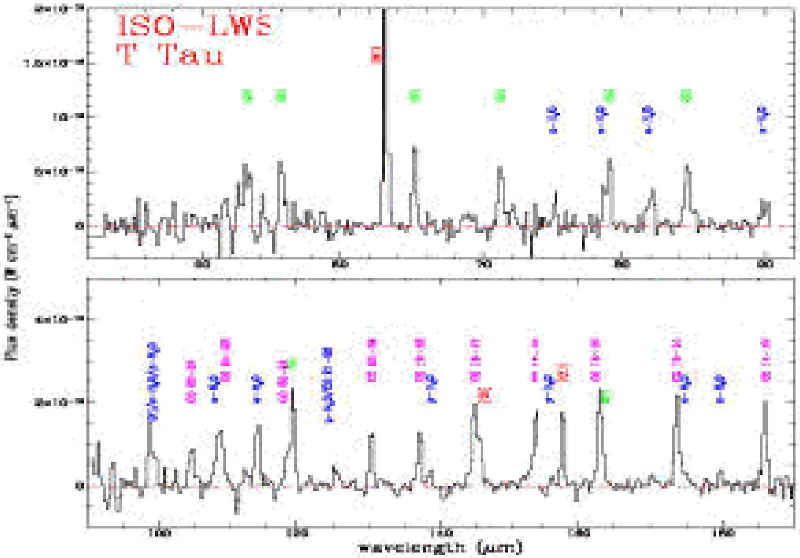
Targets	Area	6 bands maging 10σ 5)mJy		EQUIVALENT MASS T=20 K β=1,5 K_0 10^{-3} (1,3 mm)	
		PACS	SPIRE		
		[hours]		10) μm	350 μm
ρ- Oph main cloud (160 pc)	1° x 1°	17	4	0,005	10^{-3}
Perseus NGC1333 (350 pc) (& sourrounding cores)	1° x 2°	34	8	0,024	6 10^{-3}
Orion Complex (460 pc) (L1641, L1630, BN-KL, λOri)	1° x 5°	85	18	0,05	0,01
Chamaleon I (250pc)	0.5° x 2°	17	4	0,01	0,003
Serpens protocluster (310pc)	0.5° x 0 5°	4	1	0,02	0,0044
Lupus 1-2-3 (150pc)	1° x 2°	34	8	0,0044	0,001
Total	11. 2°	191	44		

- The quoted areas are of the denser part of the clusters.
- All clusters are below 500 pc where single condensation are resolved by FIRST

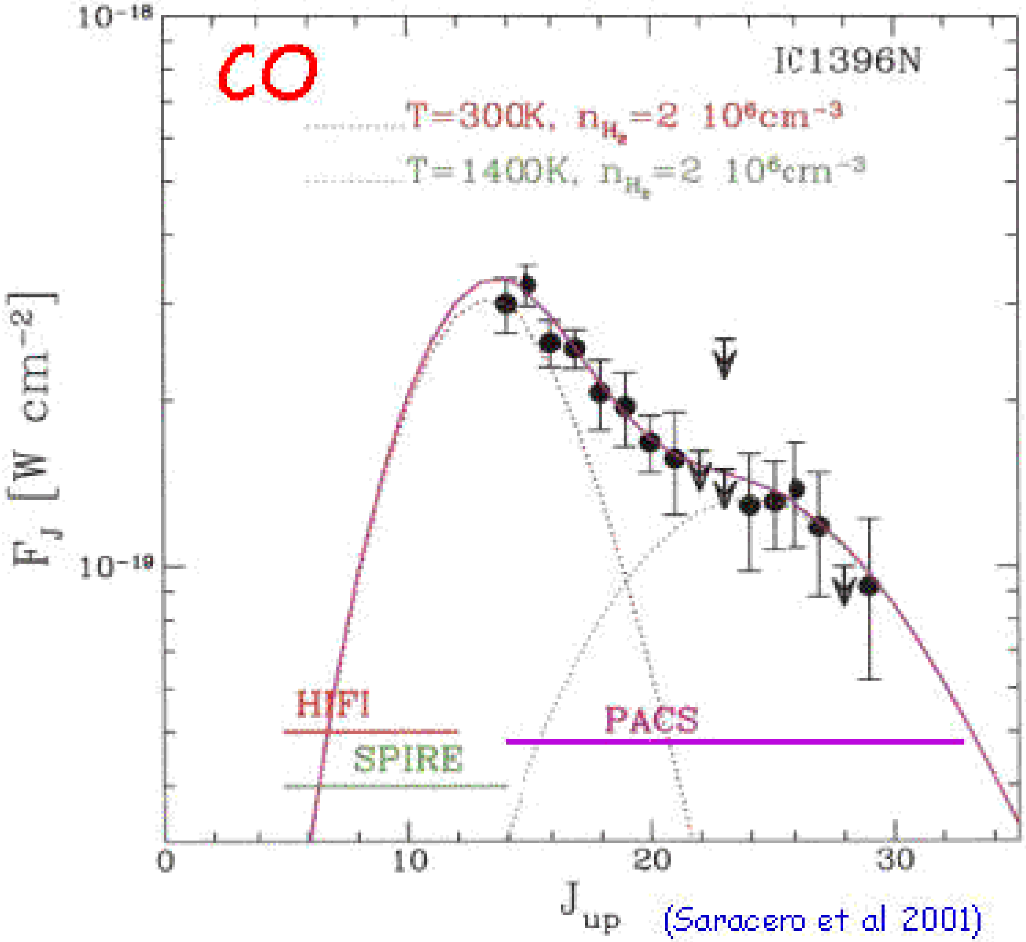
FIR lines



ISO has shown the great power of FIR lines to trace the warm gas of star forming regions where it is possible to find the signature of the interaction among the members of a clusters



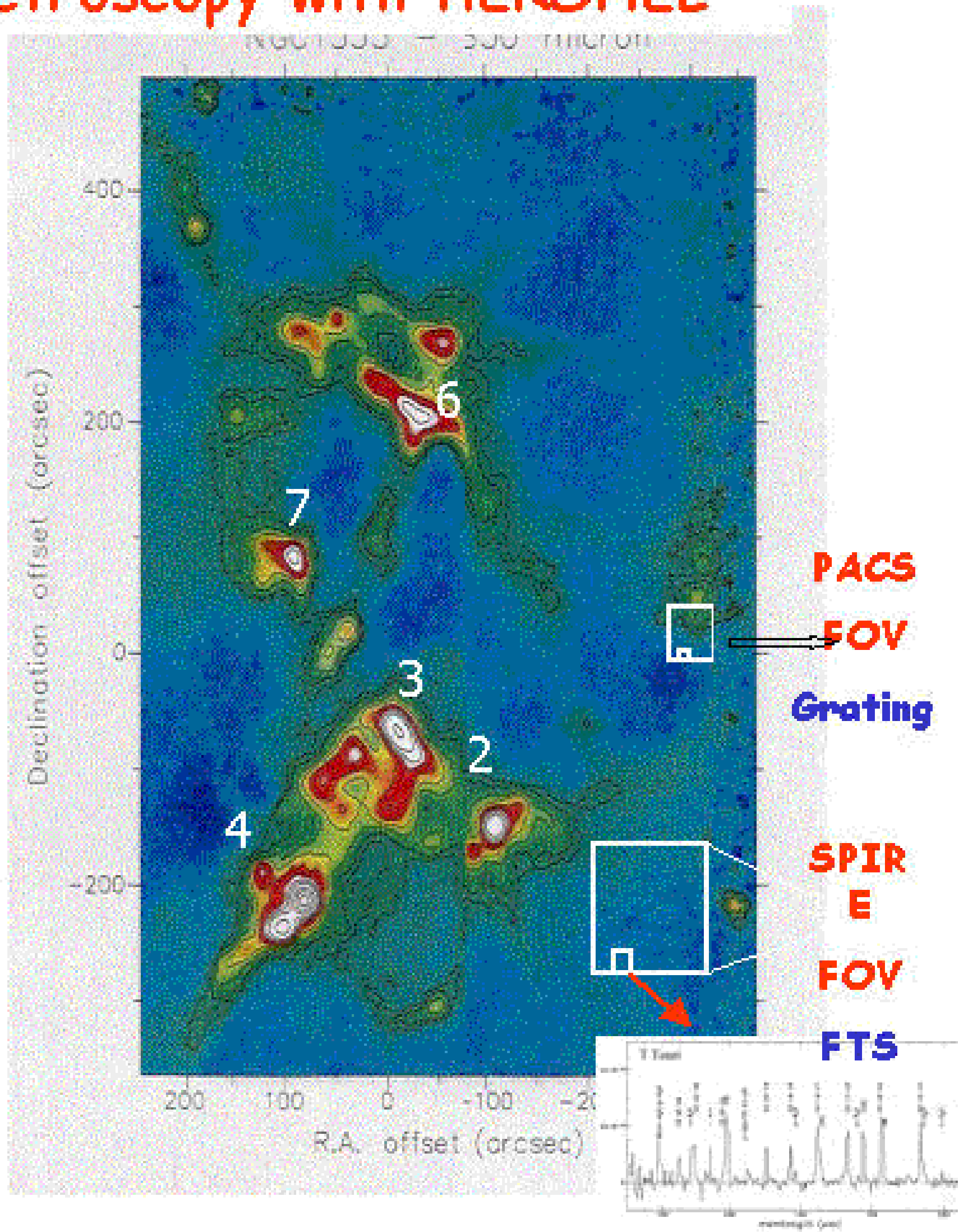
Spinoglio et al 2000



(Saracero et al 2001)

Imaging Spectroscopy with HERSHEL

HERSHEL can produce for each spatially resolved element a full spectrum at intermediate resolution tracing temperature and density of the gas the chemical species present, allowing the study of the process going on (outflow, stellar wind, Ionizing field) even in the inner part of the clusters obscurated in the NIR



Observing Strategy

·PACS & SPIRE photometry of massive cores selected at mm, ^{13}CO, CS .....

=> SEDs

=> color-color diagram

·Priority to regions within 500 pc to minimize source confusion

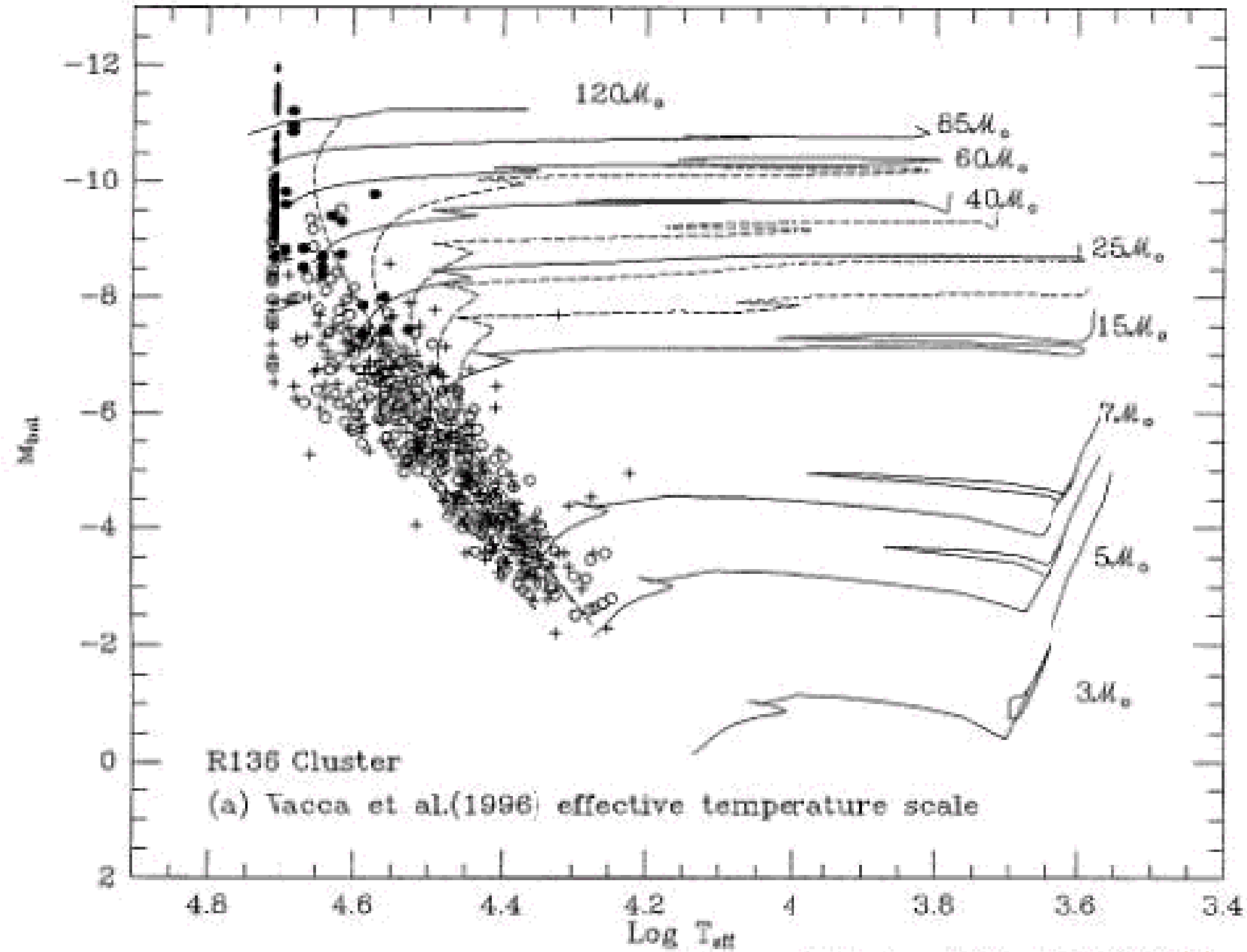
Spectroscopic follow up on selected clusters (size few arcmin):

- spectroscopy around the peak (co adding adjacent pixels)
  => accurate determination of SEDs, Tdust, Mdust
- Imaging spectroscopy (PACS & SPIRE) to study the the interaction among the member of a clusters
- High resolution spectroscopy (HIFI) => accurate dynamical and chemical studies

·Blind survey of Molecular Cloud at low priority

High Mass star formation

Star formation in clusters can explain the existence of very high mass stars



Massey & Hunter 1988 ApJ, 493,180

The Origin of Stellar Masses

Understanding the origin of Stellar masses is crucial to understand the evolution of stellar populations in our Galaxy and beyond.

- ***Most stars form in clusters: do they hold the key of IMF's origin?***

- Current millimeter surveys of protoclusters are affected by:

- uncertainties on T and dust emissivity => **inaccurate mass estimates**
- small statistics - surveys of limited area
  - limited mass range

The promise of HERSCHEL

SED from optically thin to optically thick regime
=> T and dust emssivity => **accurate mass estimate**

Sensitivity down to Prcto-Brown dwarf masses

Maps of large areas of sky good statistics

Molecular line emission from YSO's

In the FIRST range YSO's line emission is:

- mainly molecular
- associated with outflow shocks

In the outflows we observe:

- a cold (10 K) gas component (~1 mm CO, CS..) => molecular flow
- a warm (2000 K) " " (NIR H_2........) => wind
- a ionized (10^4 K) " " (UV, V, radio) => (HH, Jets)

Molecular lines (CO, H2O, OH...) in the FIRST range trace the link between the cold and the warm component:

Tex: 100 => 2000 K

and trace a relatively dense gas : $n > 10^5$ cm^{-3}

The Origin of Stellar Masses

Understanding the origin of Stellar masses is crucial to understand the evolution of stellar populations in our Galaxy and beyond.

- ***Most stars form in clusters: do they hold the key of IMF's origin?***

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The promise of HERSCHEL

SED from optically thin to optically thick regime

=> T and dust em ssivity => **accurate mass estimate**

Sensitivity down to Prcto-Brown dwarf masses

Maps of large areas of sky good statistics

SOLAR-SYSTEM OBSERVATIONS WITH HERSCHEL

FIRST PRIORITY PROGRAMS

1. H_2O in the Solar System
   SPIRE, HIFI, PACS
2. Far-IR photometry of TNOs
   SPIRE, PACS

3. Giant planets: formation and evolution
   SPIRE, PACS, HIFI?
4. Mars aeronomy and photochemistry
   HIFI, SPIRE, PACS
5. Chemical composition of small bodies
   PACS, SPIRE

SPIRE Consortium Meeting
July 4-6, 2001

Therese Encrenaz
DESPA, Observatoire de Paris

H_2O in the Solar System

COMETS

H_2O
- main constituent in comets
- main driver of cometary activity for $R_h < 3$ AU

Previous observations with ISO, SWAS, ODIN

Scientific goals of Herschel observations

- Water production — SPIRE/FTS, PACS, HIFI
- Kinematics — HIFI
- Physical conditions in the inner coma
- Spin temperature (from OPR)
- D/H

} SPIRE/FTS, PACS

Which targets?

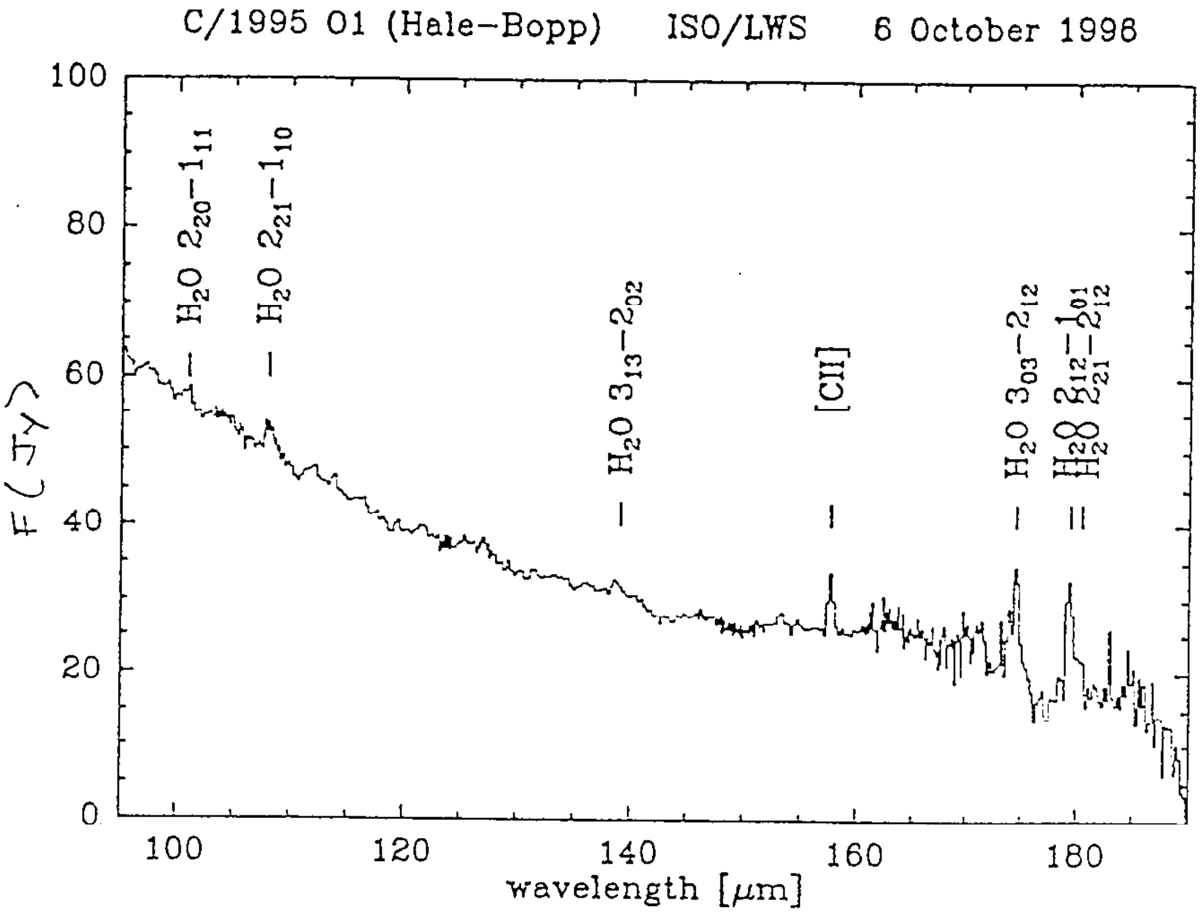
HIFI – 557 GHz H_2O

$Q > 3\ 10^{26}\ s^{-1} \rightarrow 10$ comets/y

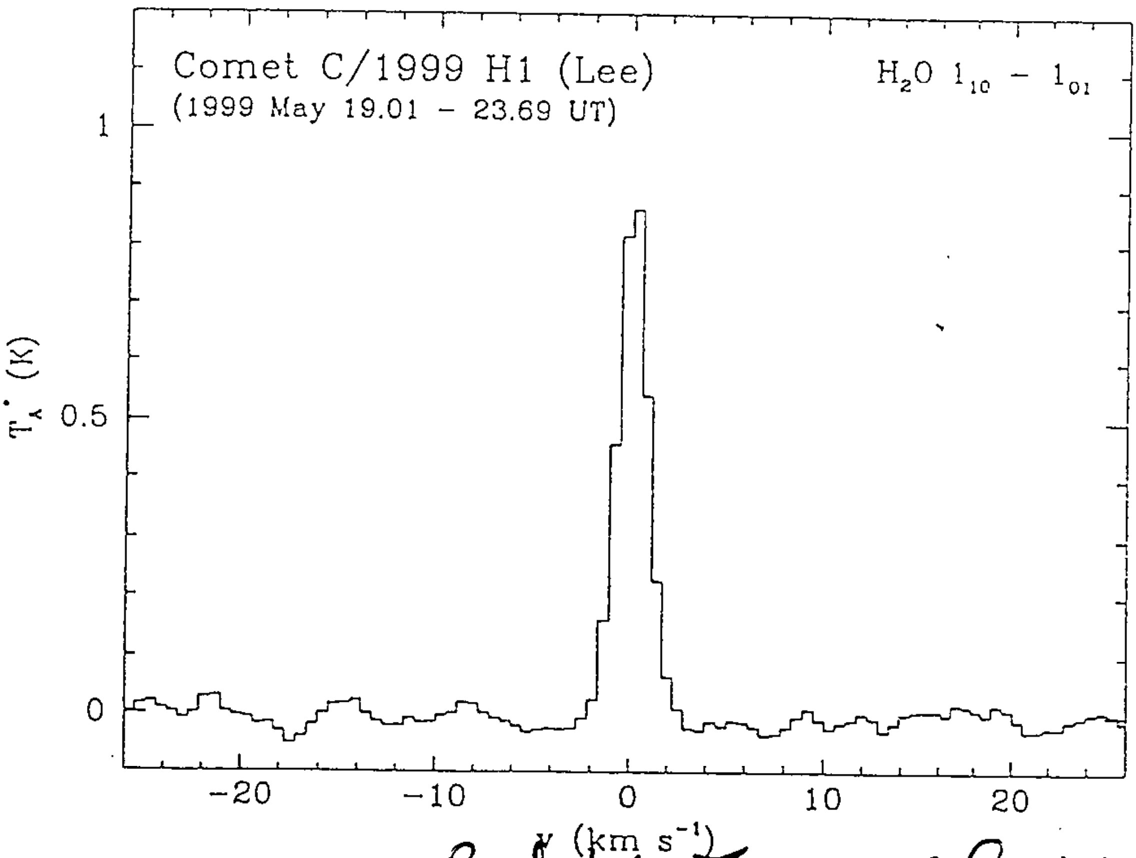
SPIRE-FTS + PACS

$Q > 5\ 10^{27}\ s^{-1} \rightarrow 4$ comets/y

ISO-LWS

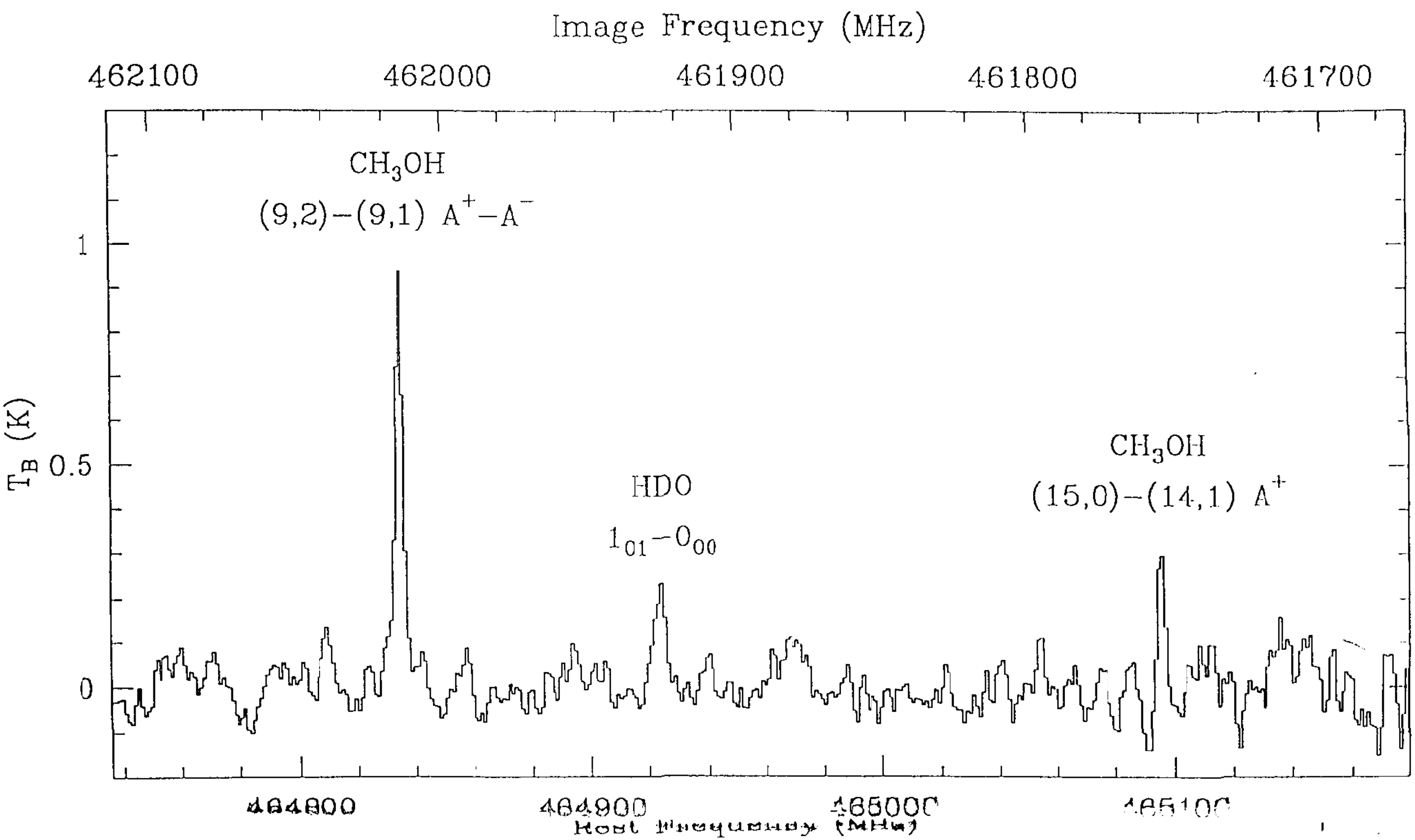


SWAS



Bockelée-Morvan & Crovisier 2001

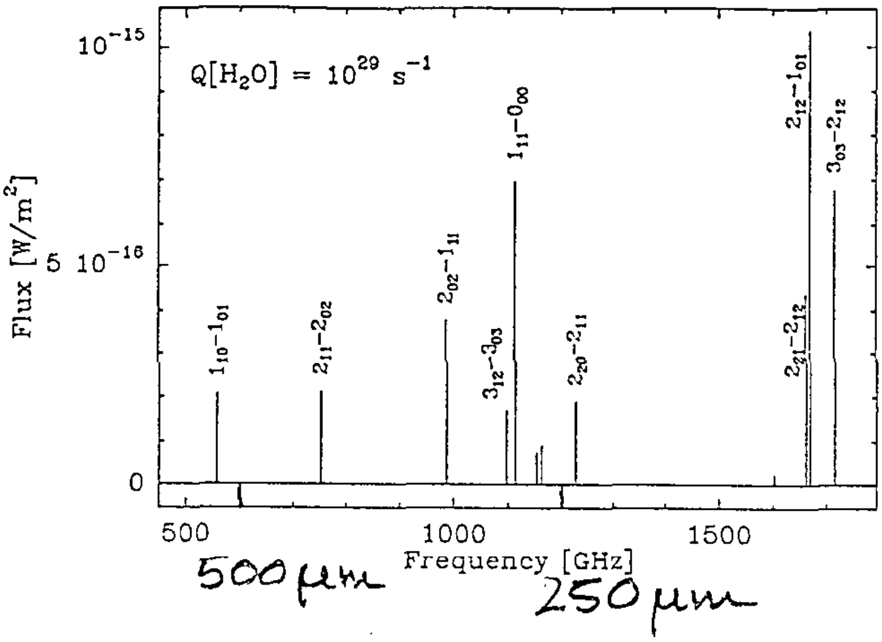
HDO on Hyakutake



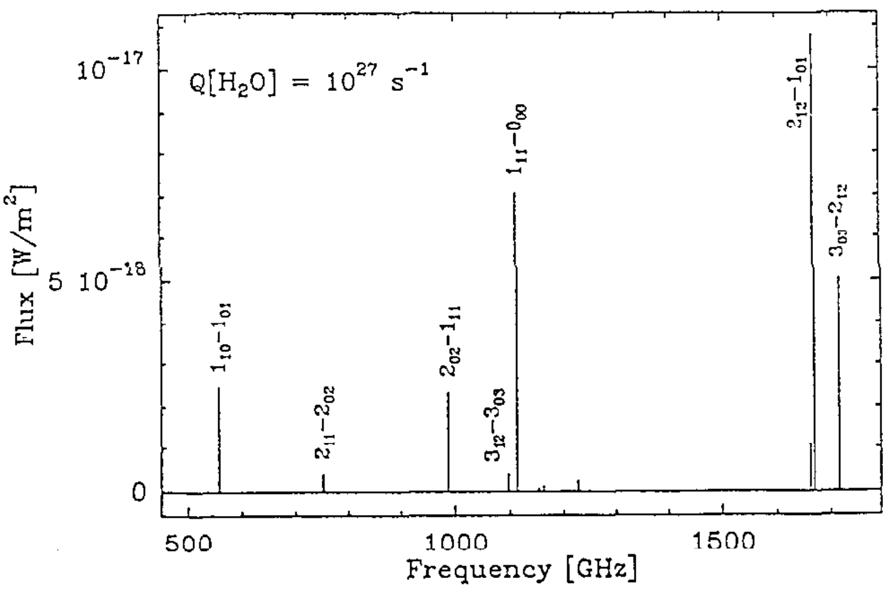
Bockelée-Morvan et al
1998

Modelling of H_2O rotational lines

$Q = 10^{29}\ s^{-1}$



$Q = 10^{27}\ s^{-1}$



Bockelée-Morvan and Crovisier, 2001

GIANT PLANETS

H_2O detected in the stratospheres of all giant planets + Titan (ISO-SWS)

H_2O has to be of external origin (source still unclear : local / interplanetary)

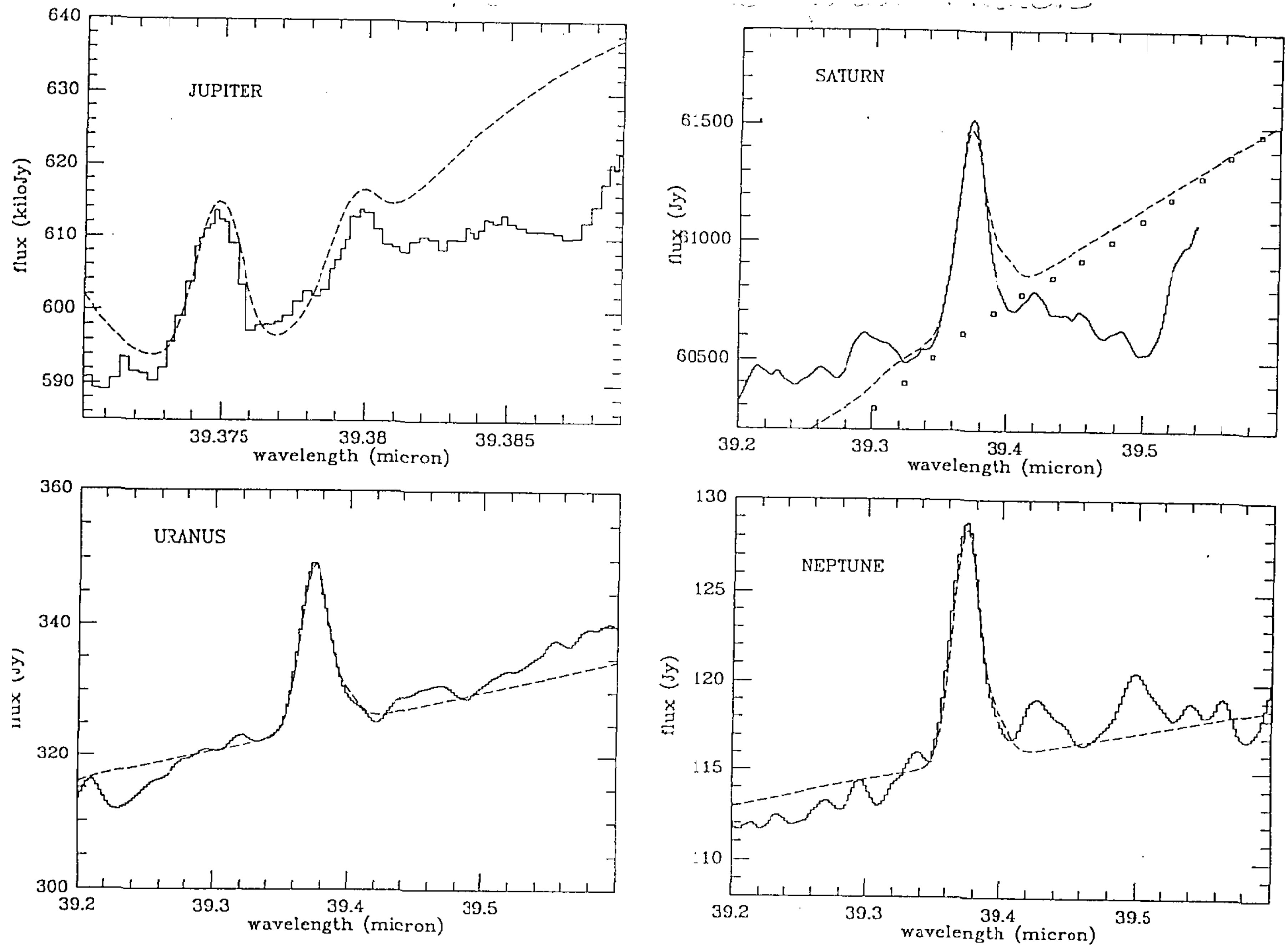
Scientific goal with HERSCHEL

- Better constrain the H_2O vertical distribution (HIFI, SPIRE-FTS)
- Jupiter : low-resolution mapping (PACS)

MARS

Scientific objective

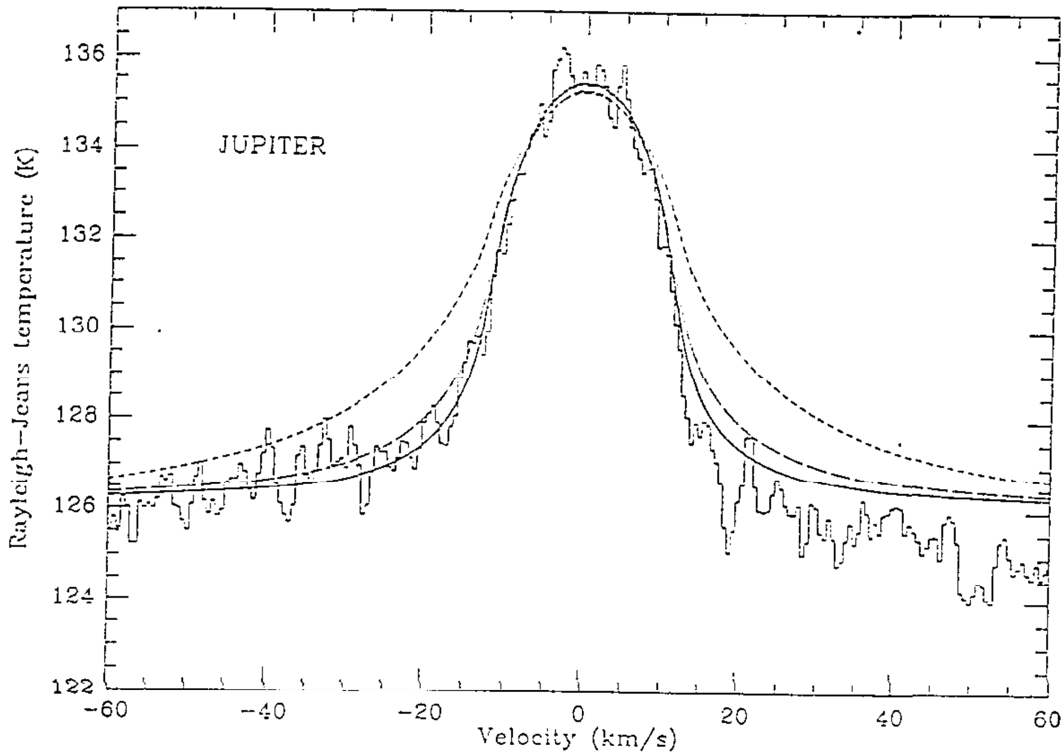
- Precise determination of D/H (HIFI, SPIRE-FTS)
- Water cycle on Mars (PACS, SPIRE-FTS)



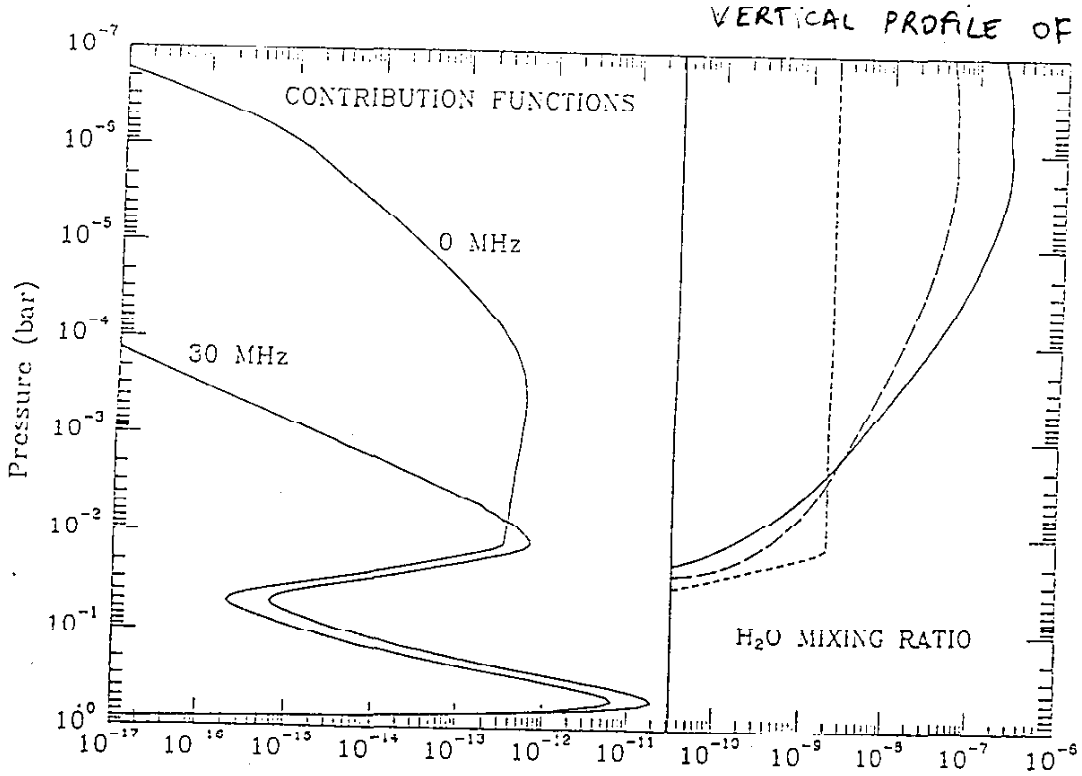
ISO - SWS
$\lambda = 39.4$ μm

Lellouch et al, 1999

SWAS : detection of H_2O 557 GHz at Jupiter
(Bergin et al. 2000)



VERTICAL PROFILE OF H_2O



Far-IR photometry of TNOs

> 300 trans-neptunian objects detected so far (in the visible)

- Ø a few hundred km
- T ~ 40 K
- R_h 30–50 AU

Expected population ~ 10^4

Scientific objective with Herschel

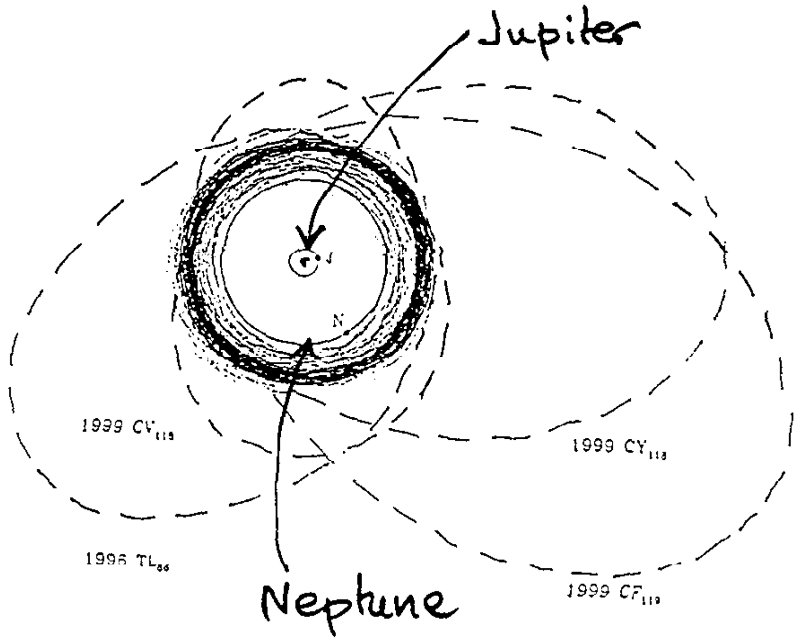
Far-IR photometry of TNOs
→ T, r

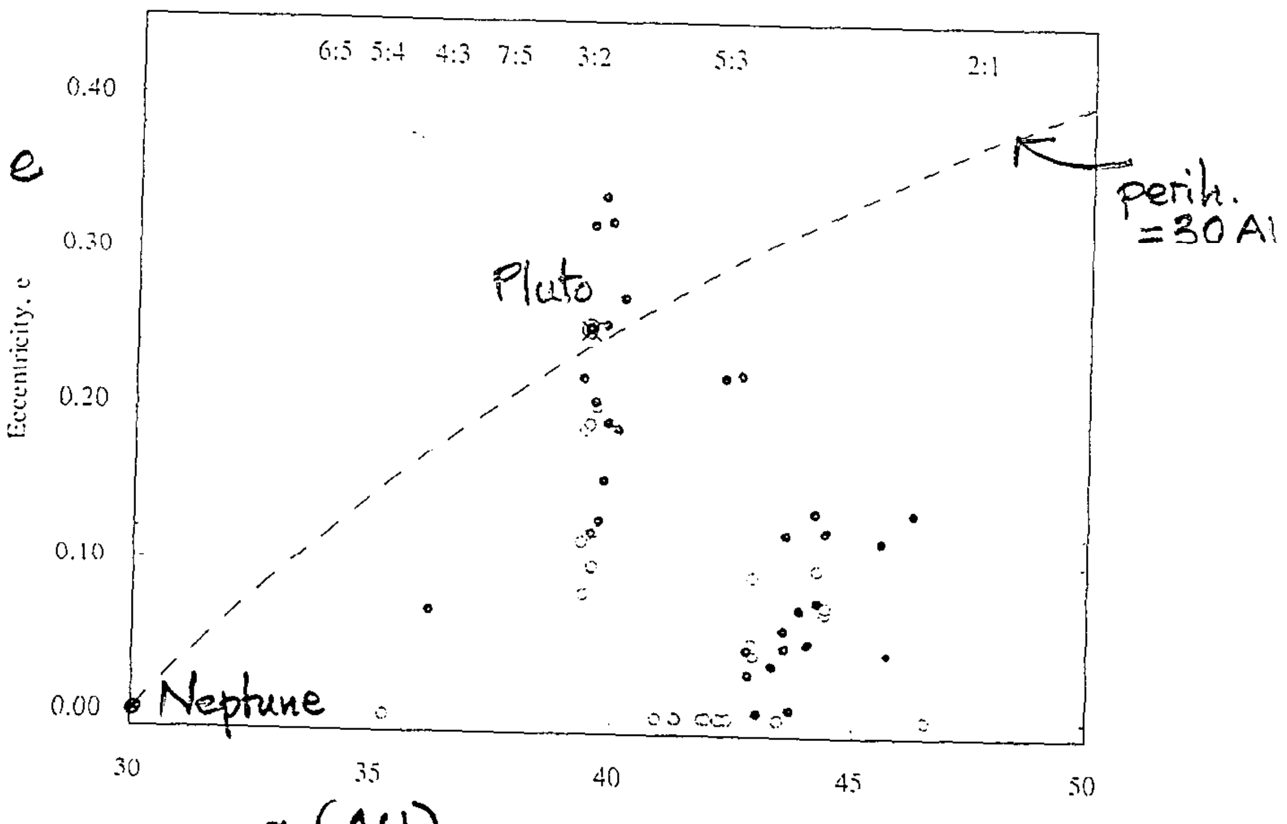
Combined with visible measur^ts^ (ar^2) → albedo

Instruments : PACS, SPIRE

Number of targets needed for statistical study : ≥ 100

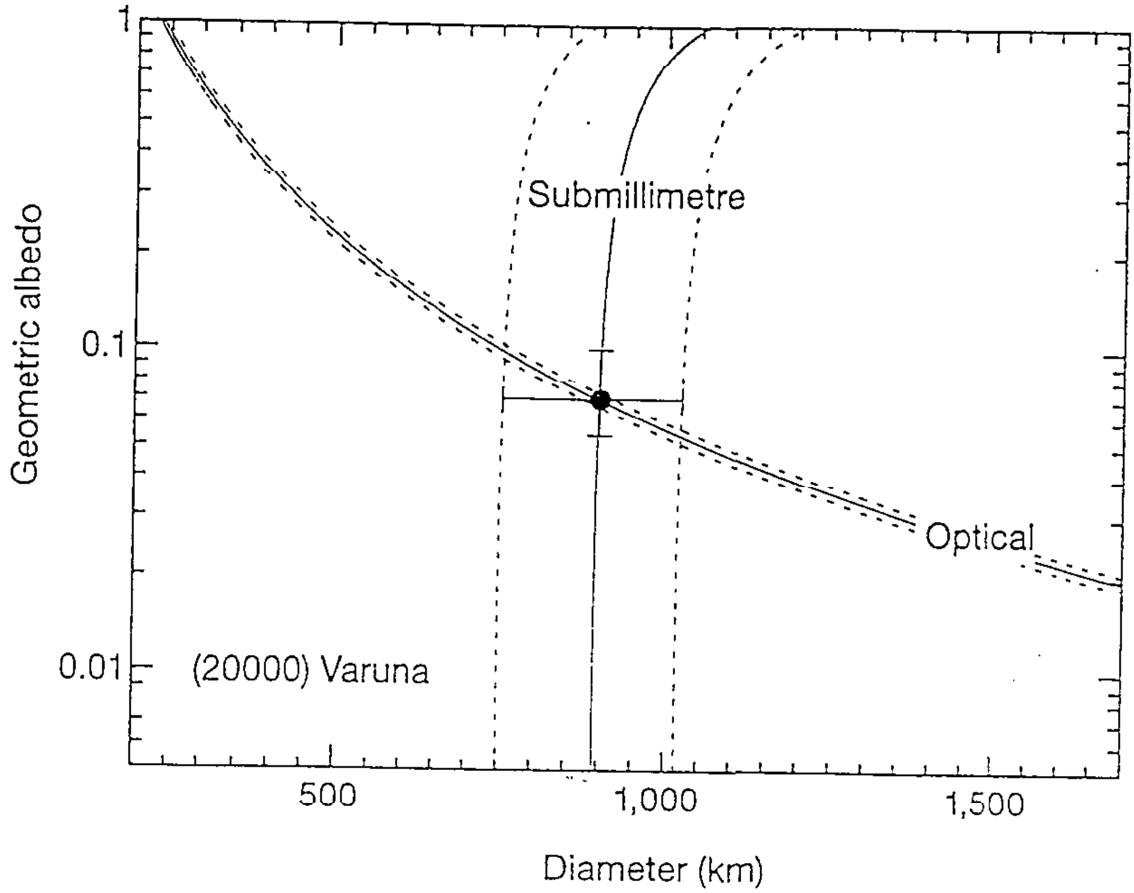
The Kuiper Belt

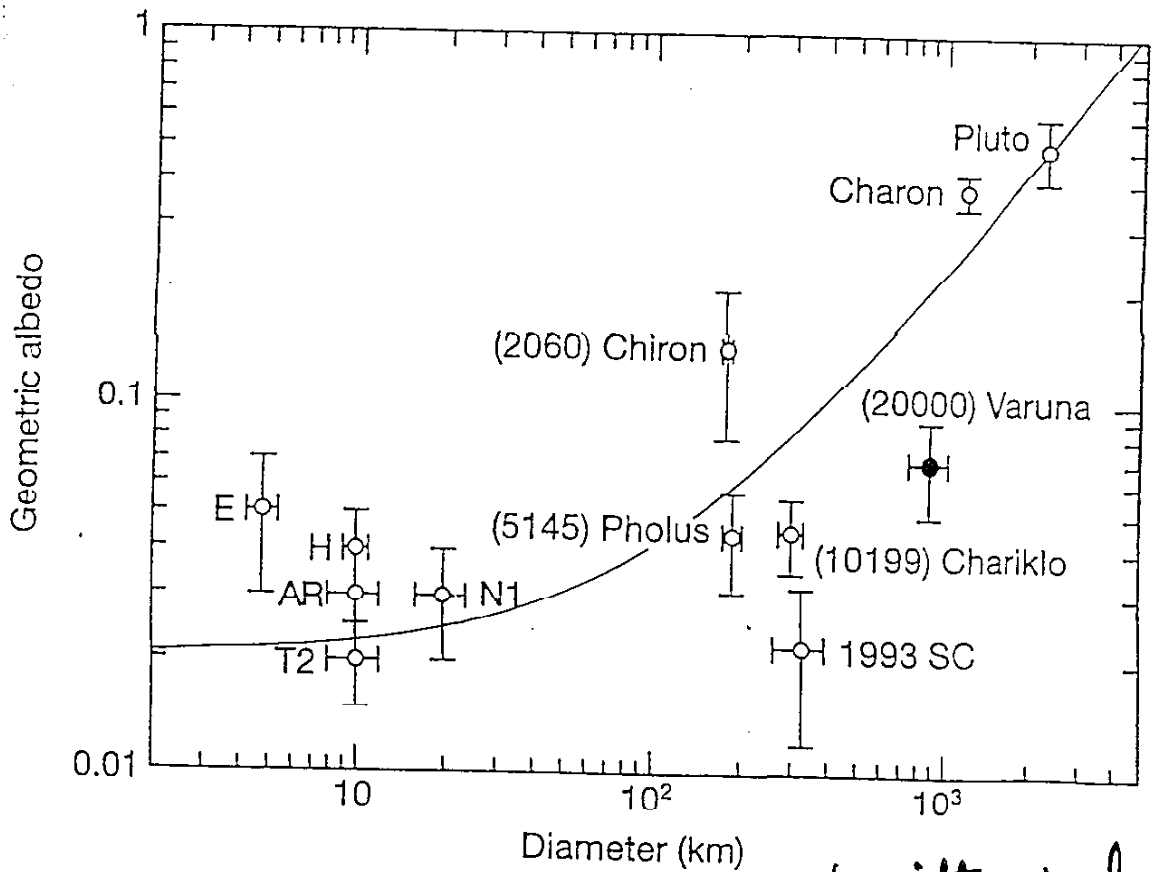




Luu, 2001

Observation of Varuna (20000)
ϕ = 900 km, a = 0.07





Jewitt et al, 2001

Giant Planets
Formation and evolution

D/H

Jupiter, Saturn → ~ protosolar

Uranus, Neptune → D enriched in ices → formation scenario

Present measurements : ISO, Galileo (J)

Goal with Herschel :
better accuracy PACS, HIFI ?

He/H

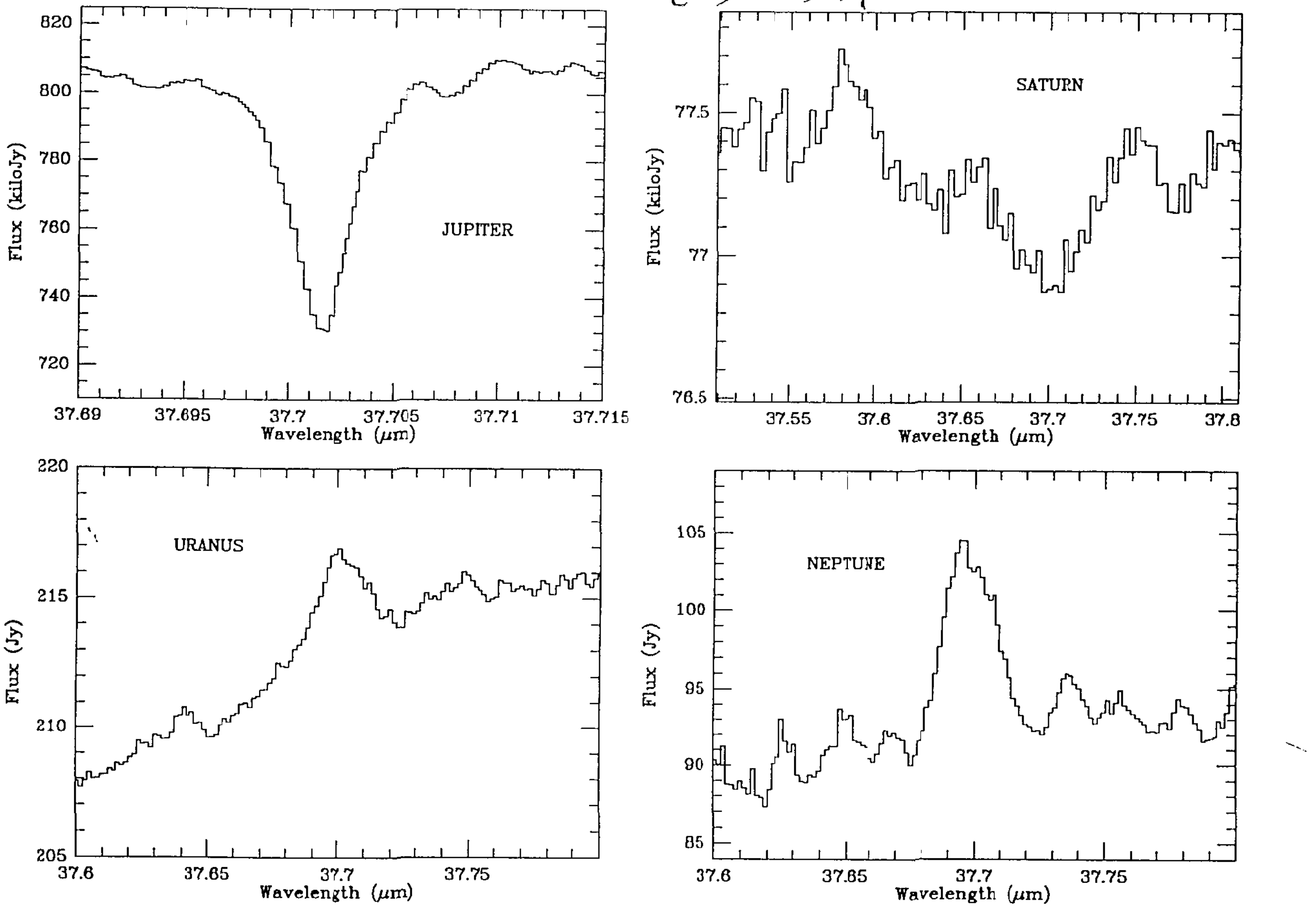
Jupiter, Saturn : He differentiation in the interior → evolution models

Uranus, Neptune : protosolar value ?

Present measurements : Voyager, ISO

Goal with Herschel :
better accuracy PACS, SPIRE-FTS

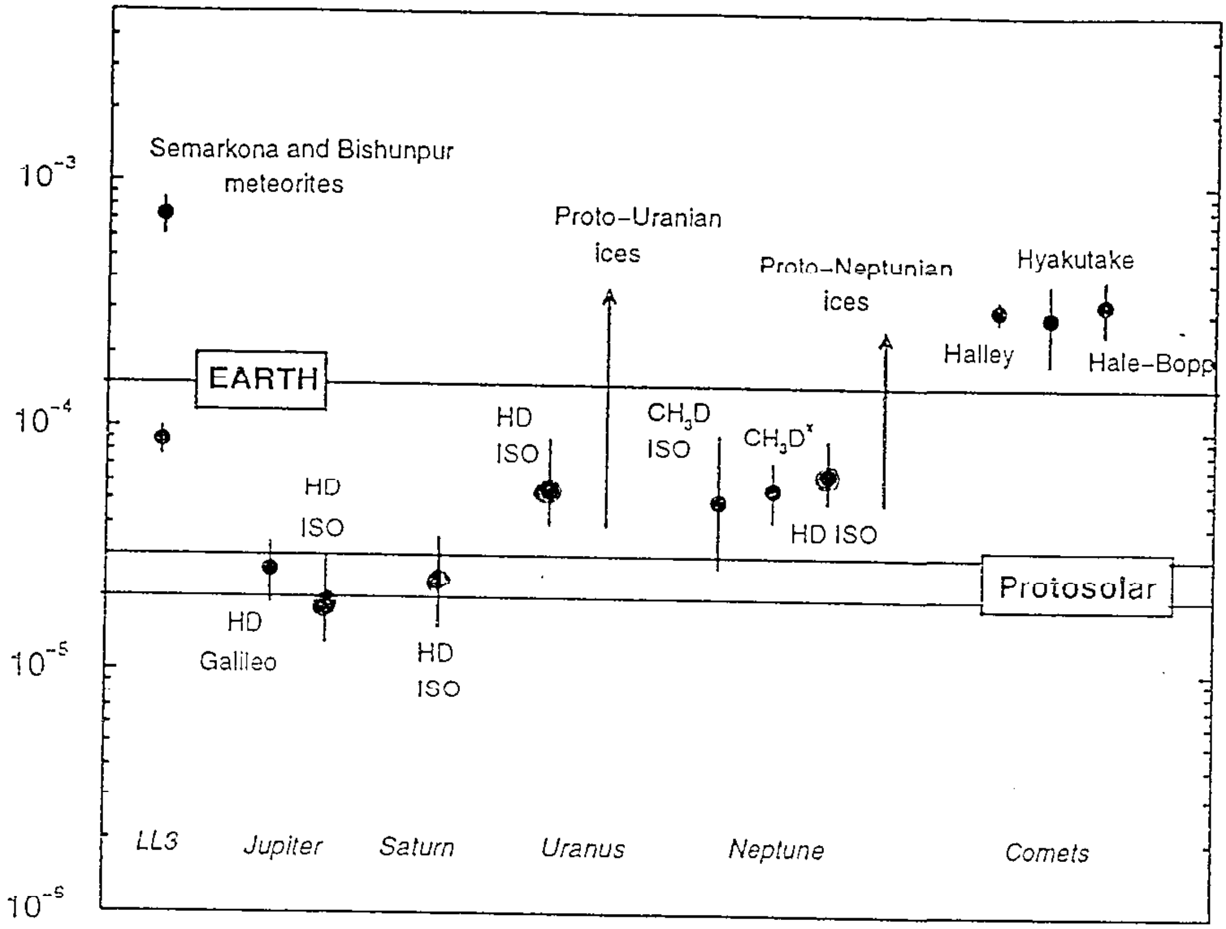
Additional science :
Exploratory search for minor stratospheric species
(PACS, SPIRE-FTS)



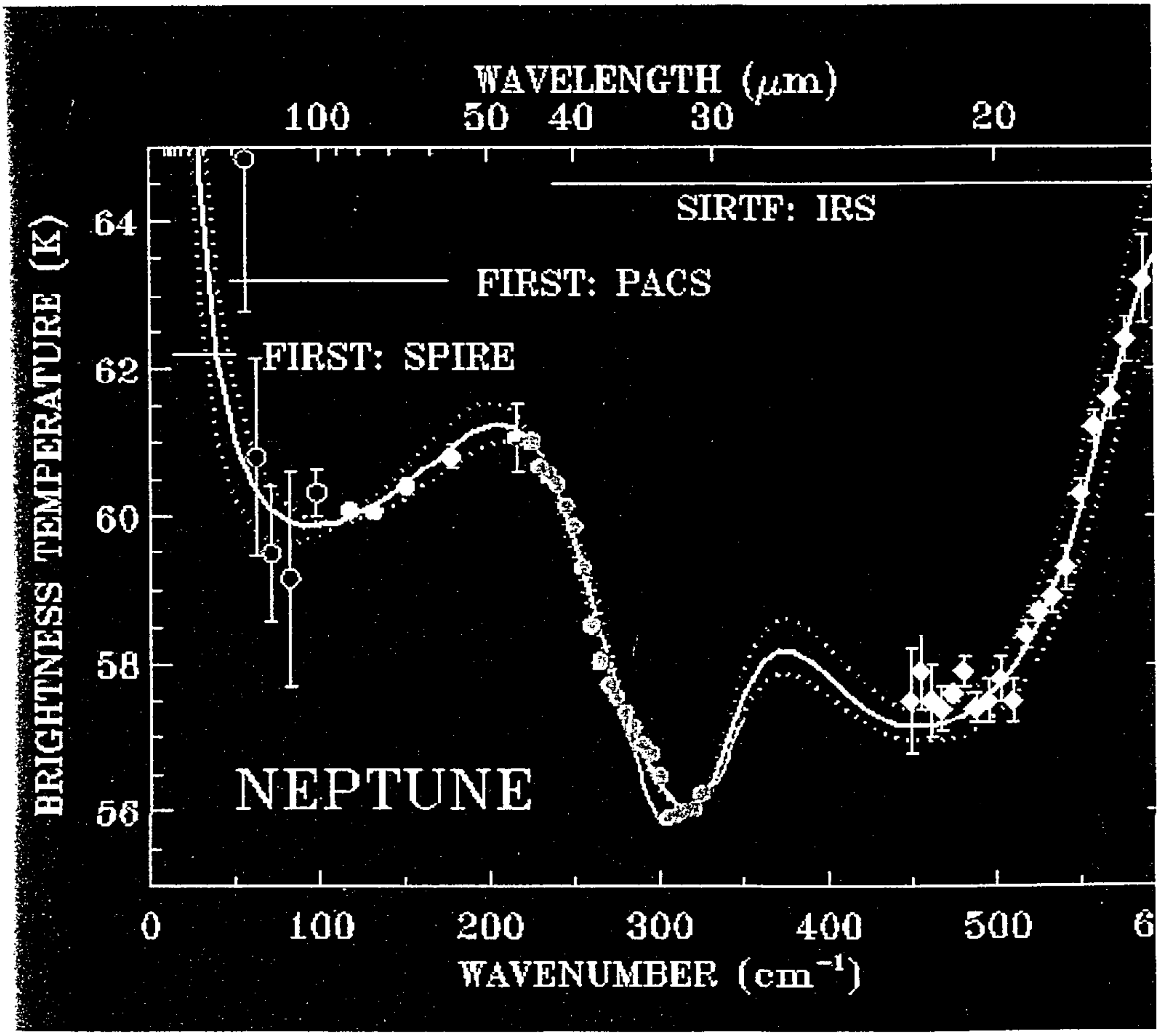
ISO/SWS

Lellouch et al, 2001

D/H in the Solar System

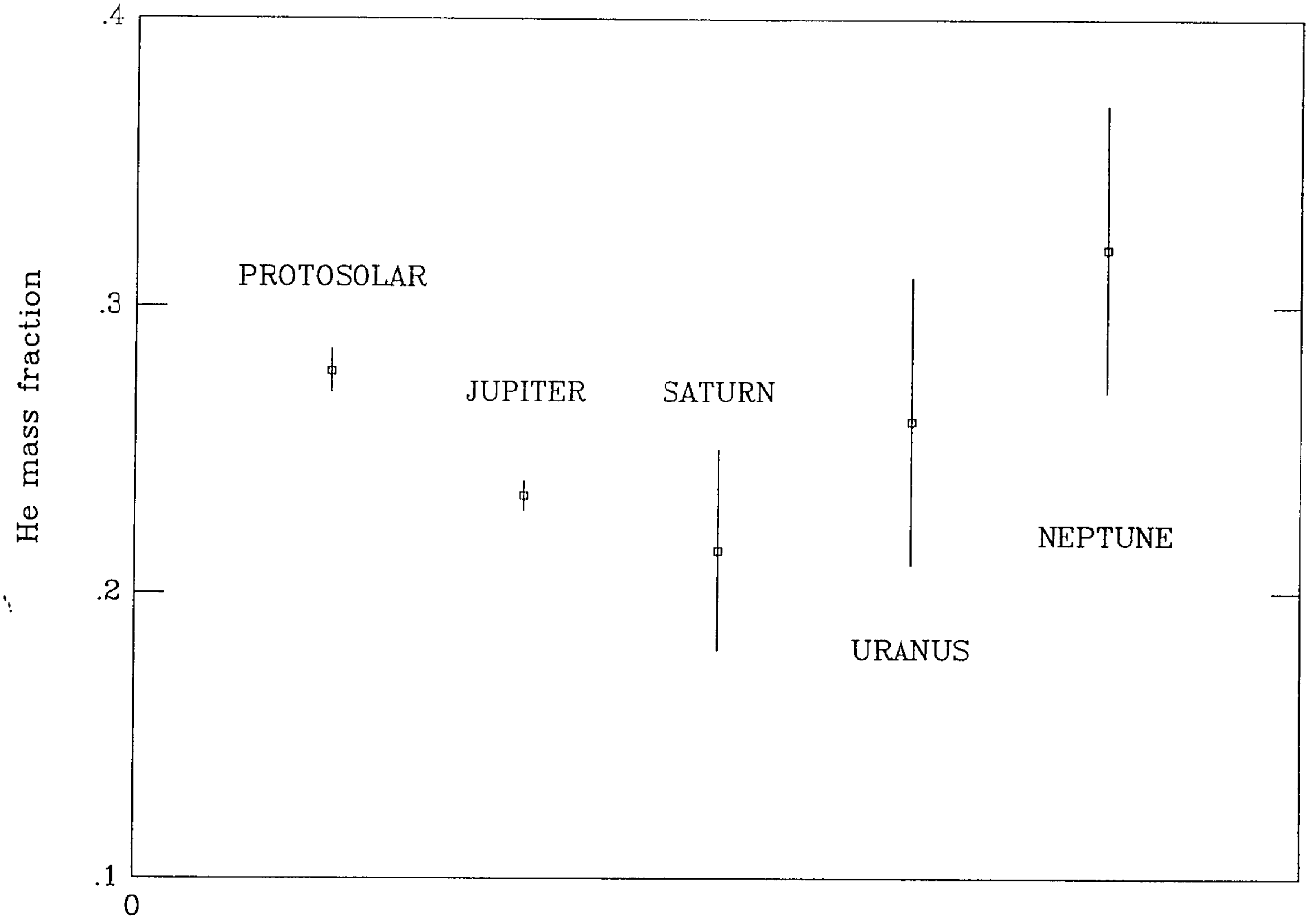


Bockelée-Morvan and Crovisier, 2001



$$\left(\frac{He}{H_2 + He}\right)_{volume} = (15 \pm 7)\%$$

Orton et al. 2000


He mass fraction
.4
.3
.2
.1
0
PROTOSOLAR
JUPITER
SATURN
URANUS
NEPTUNE

Mars

Aeronomy and photochemistry

- Search for oxygen-bearing constituents (H_2O_2) SPIRE-FTS, PACS
  HIFI (a few lines)
- Spectroscopic survey with HIFI (exploratory)

NB : Herschel instruments are unique for this science

Chemical composition of small bodies

ISO : first identification of cometary dust in Hale-Bopp

Scient. obj: extension toward sub-mm (asteroids, bright comets)

PACS, SPIRE-FTS

University of Lethbridge Mach-Zehnder FTS

David Naylor, Jacob Ellegood, Brad Gom

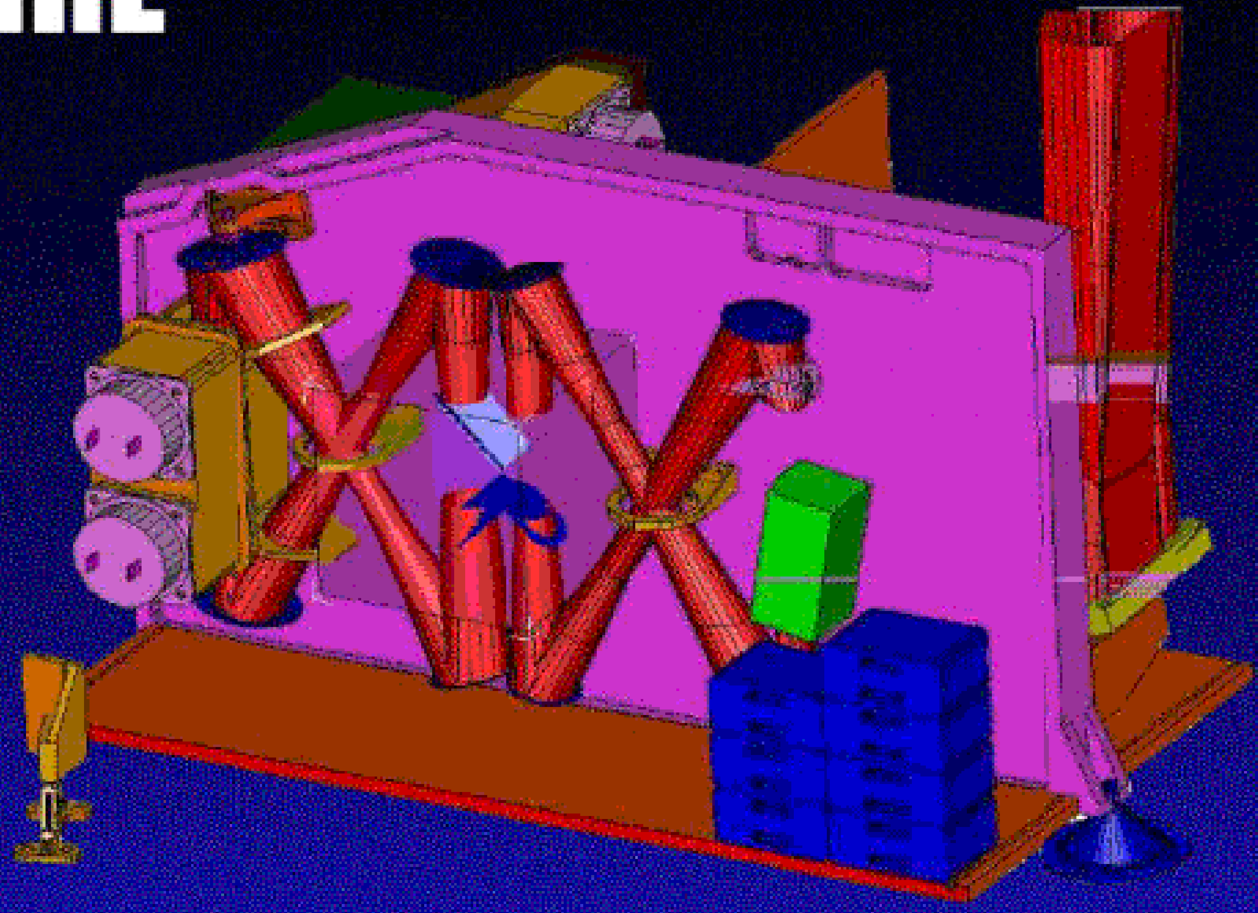
Frank Klassen, Alexandra Pope, Ian Schofield,

Arvid Schultz & Greg Tompkins (Lethbridge)

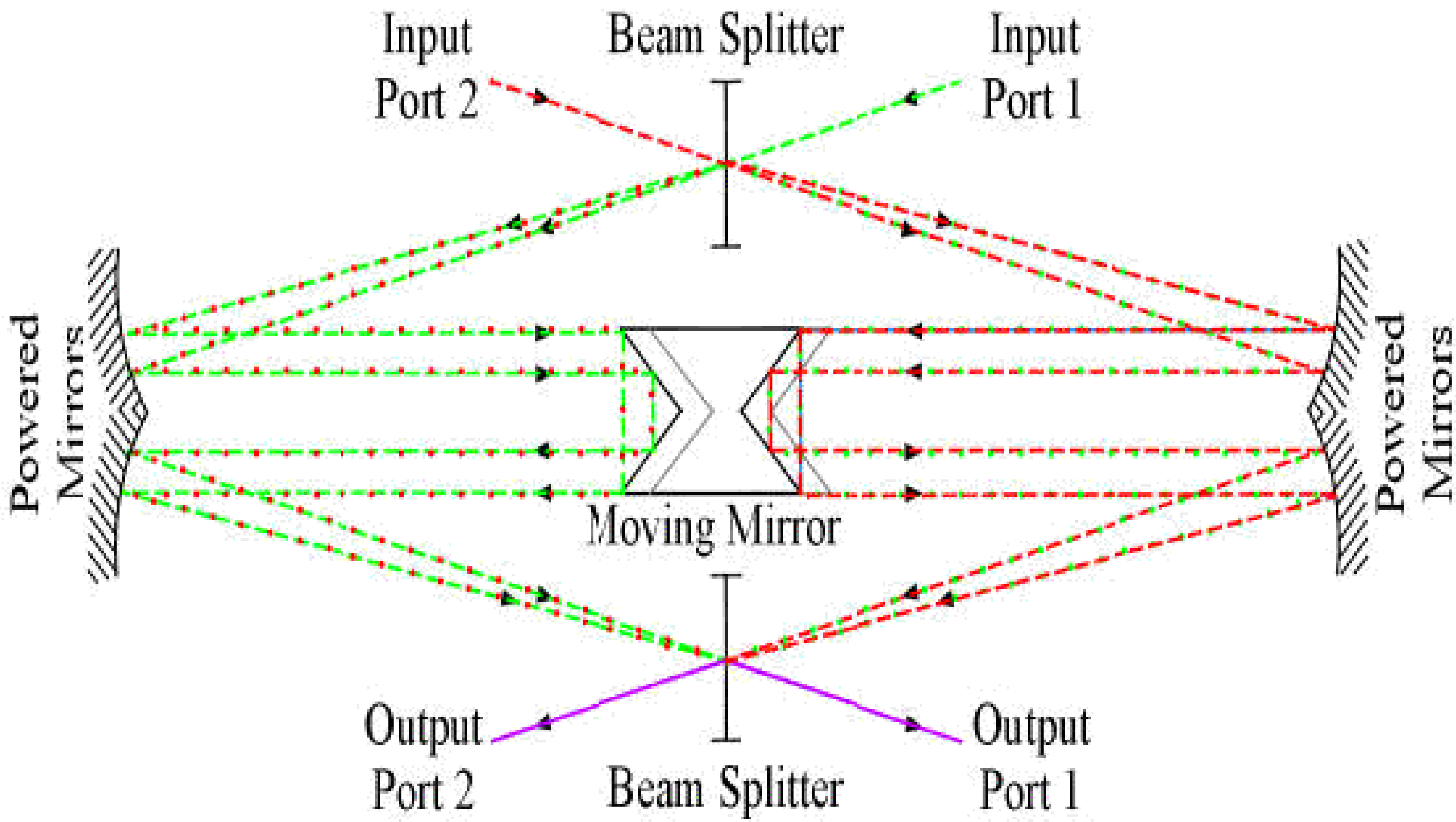
Gary Davis (Saskatchewan)

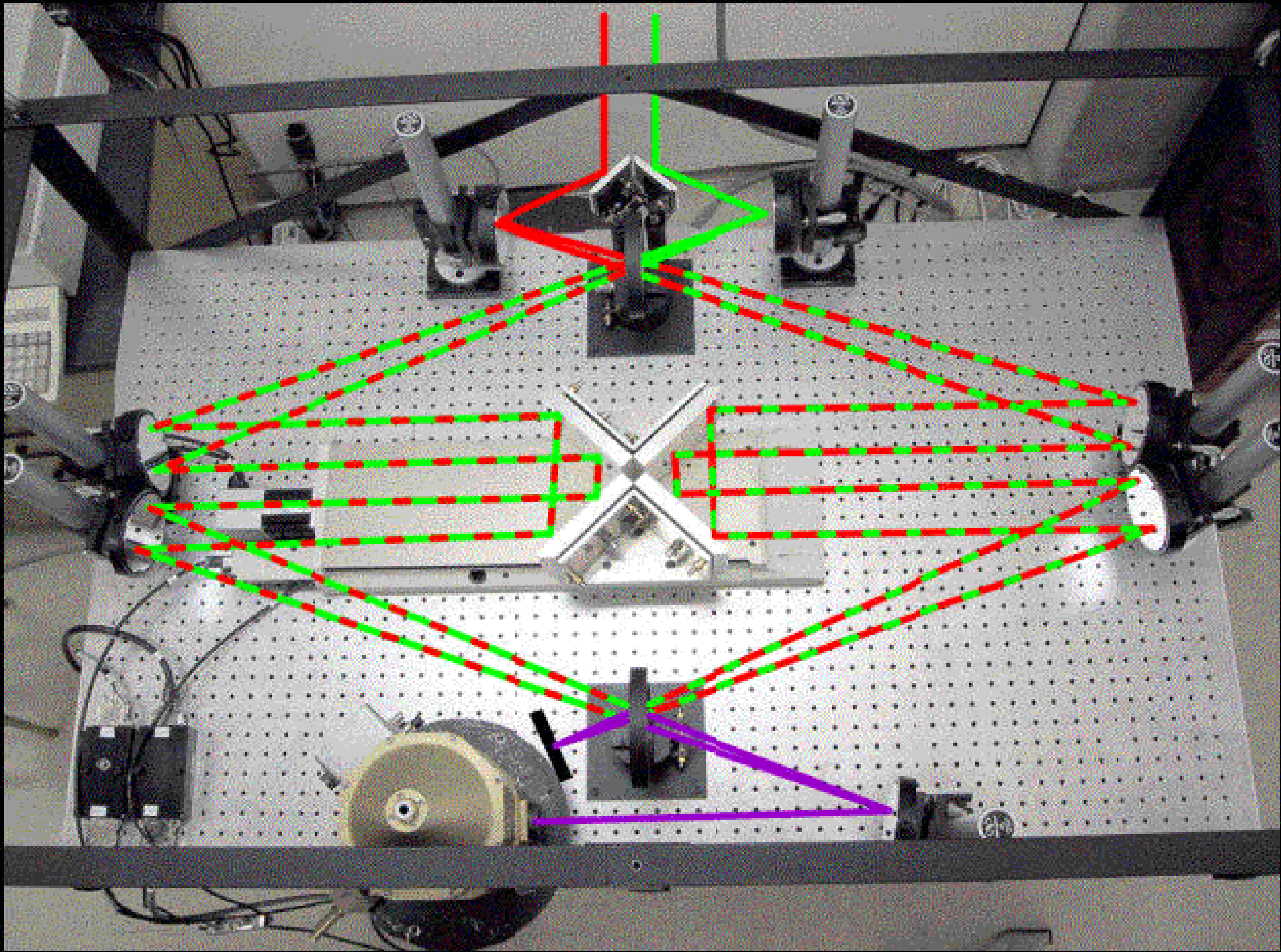
Peter Ade (Cardiff)

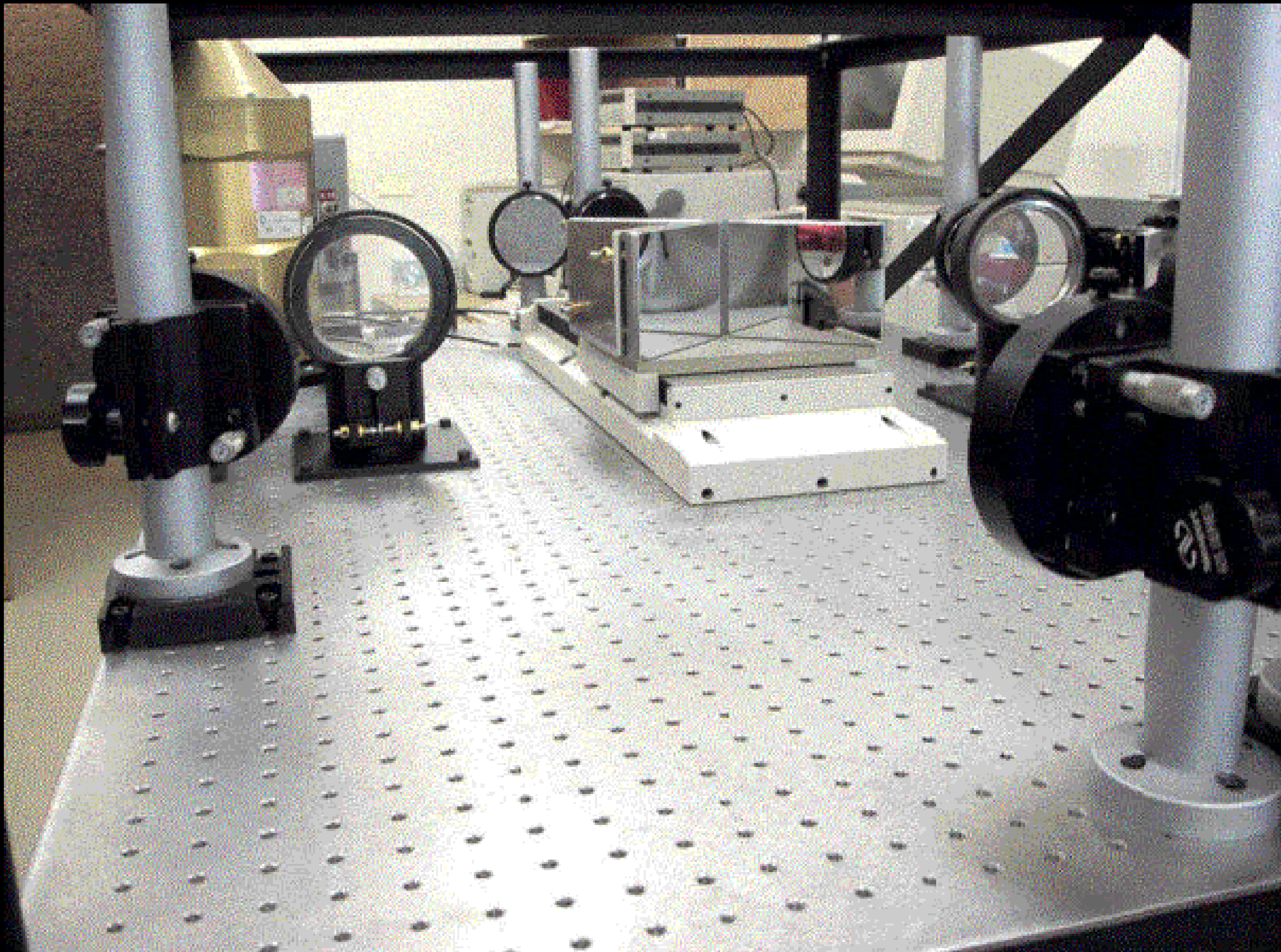
SPIRE

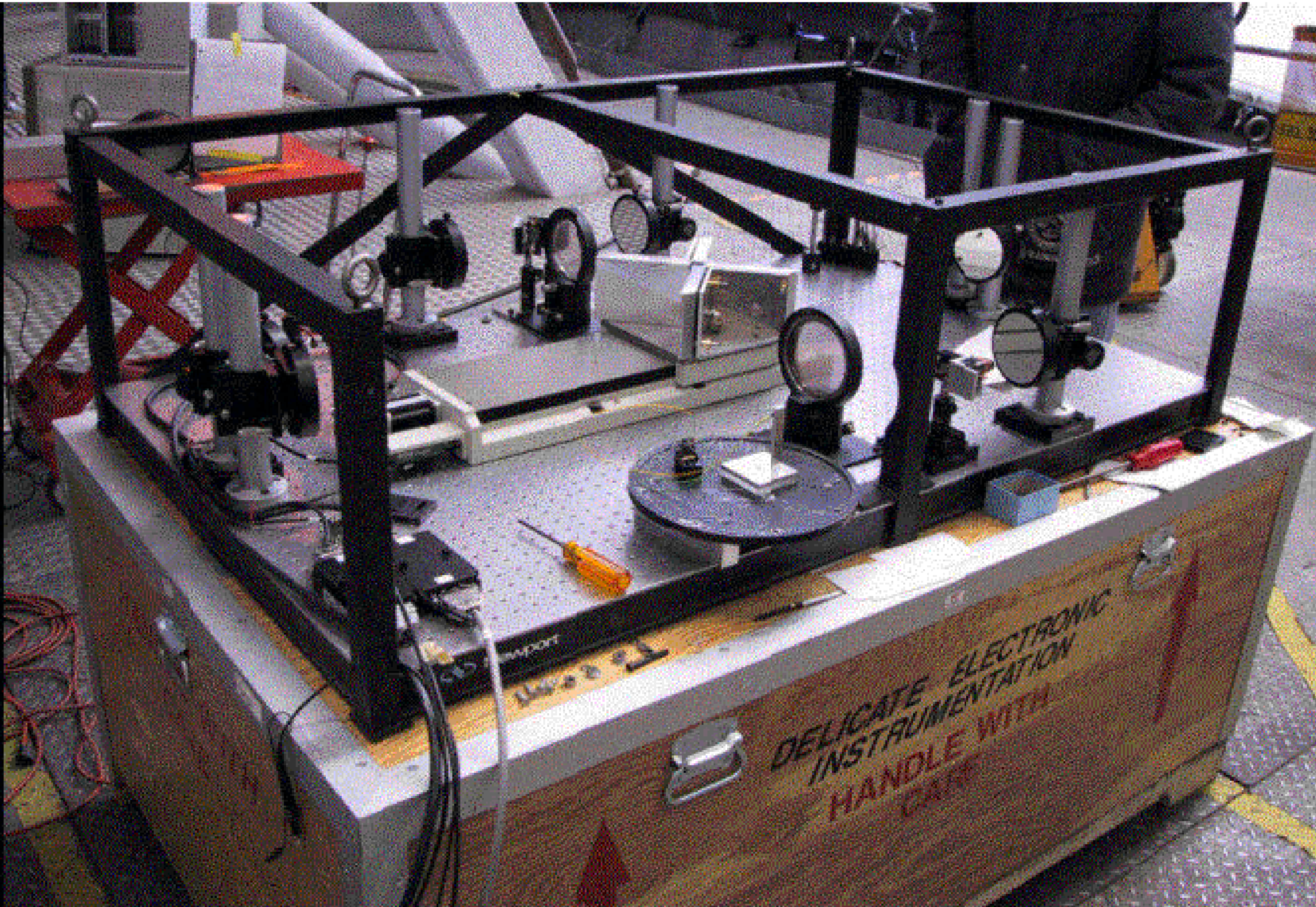


Mach-Zehnder FTS Design







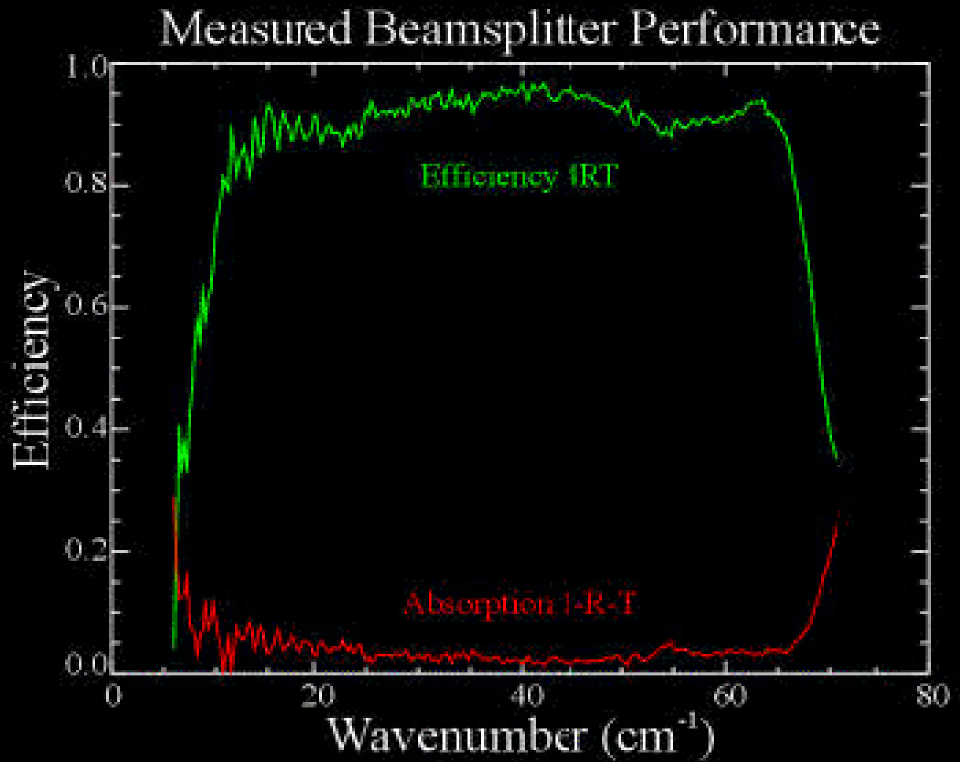

DELICATE ELECTRONIC
INSTRUMENTATION
HANDLE WITH
CARE

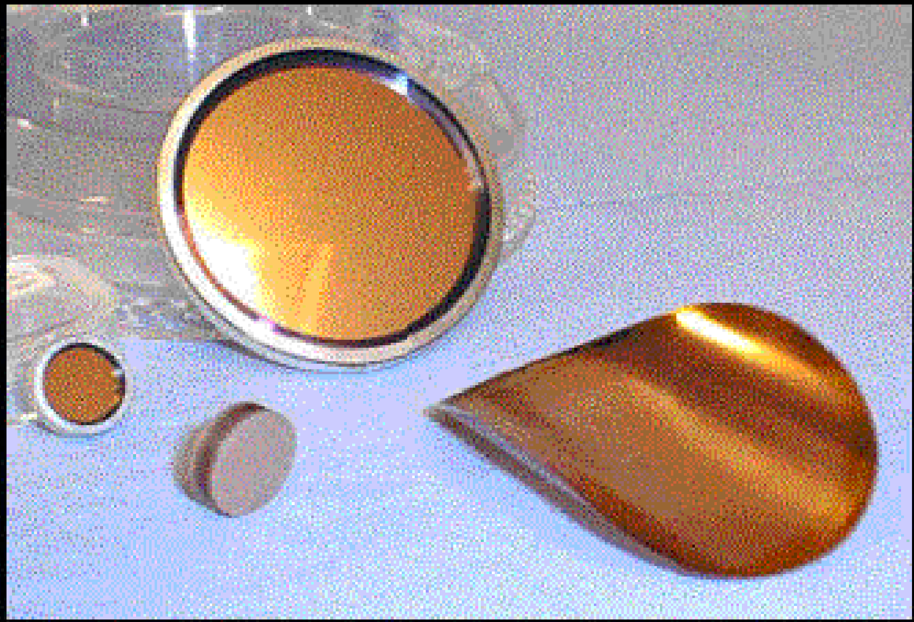

The University of Lethbridge
MACH ZEHNDER
FOURIER TRANSFORM SPECTROMETER

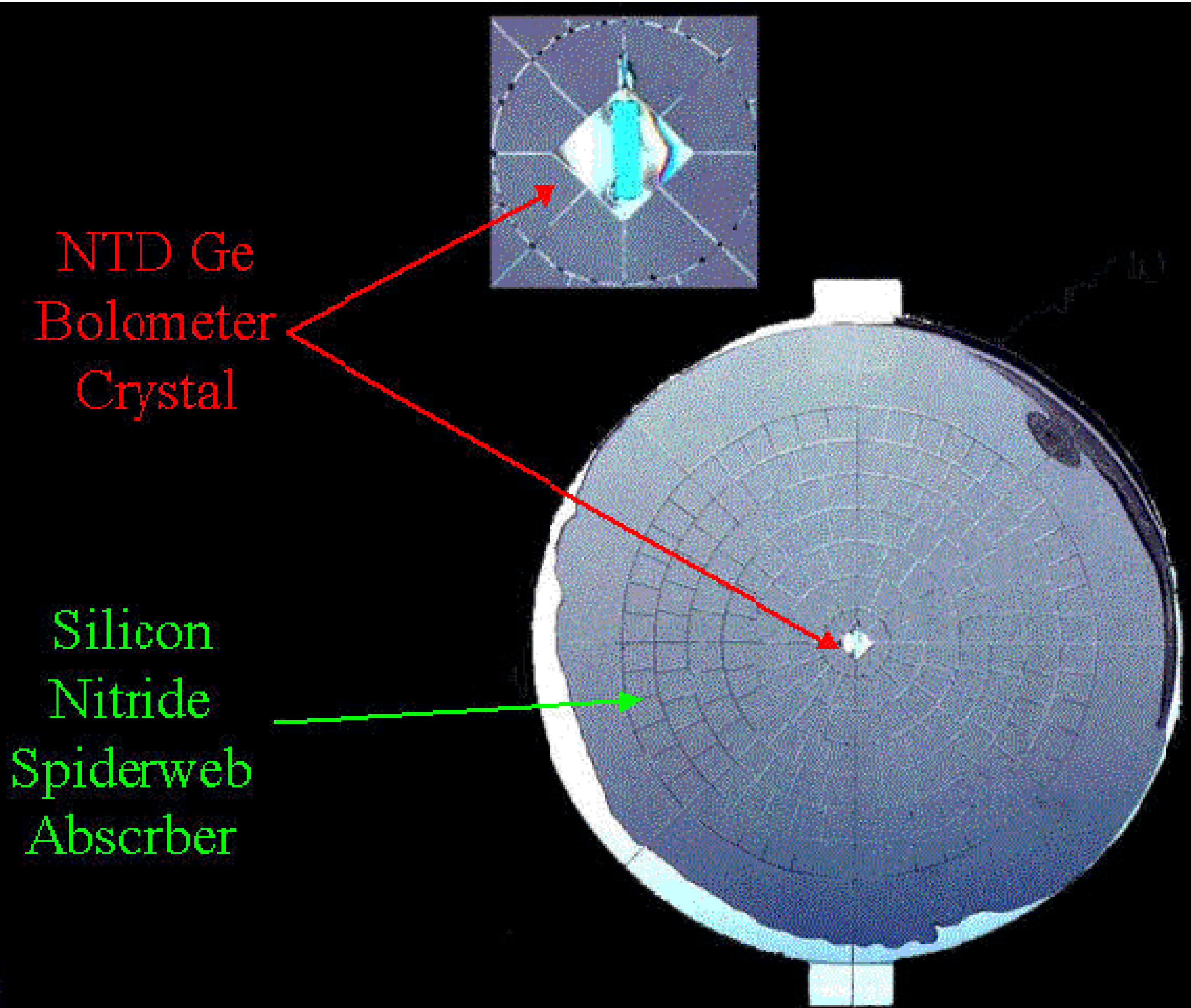

The University of Lethbridge
MACH ZEHNDER
FOURIER TRANSFORM SPECTROMETER

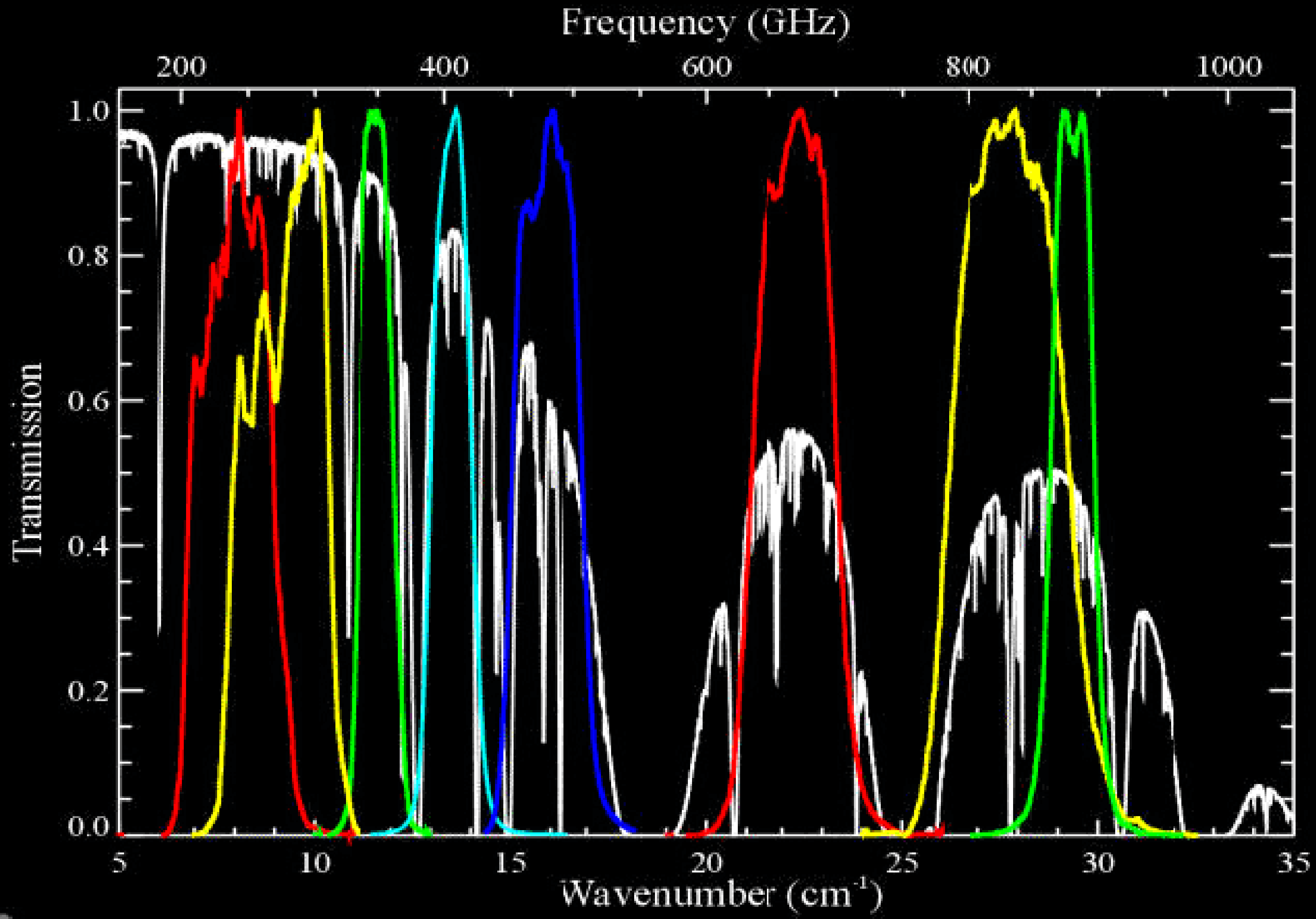
Beam Splitters

- Developed by Peter Ade
- Metal mesh interference filters on Mylar substrate.

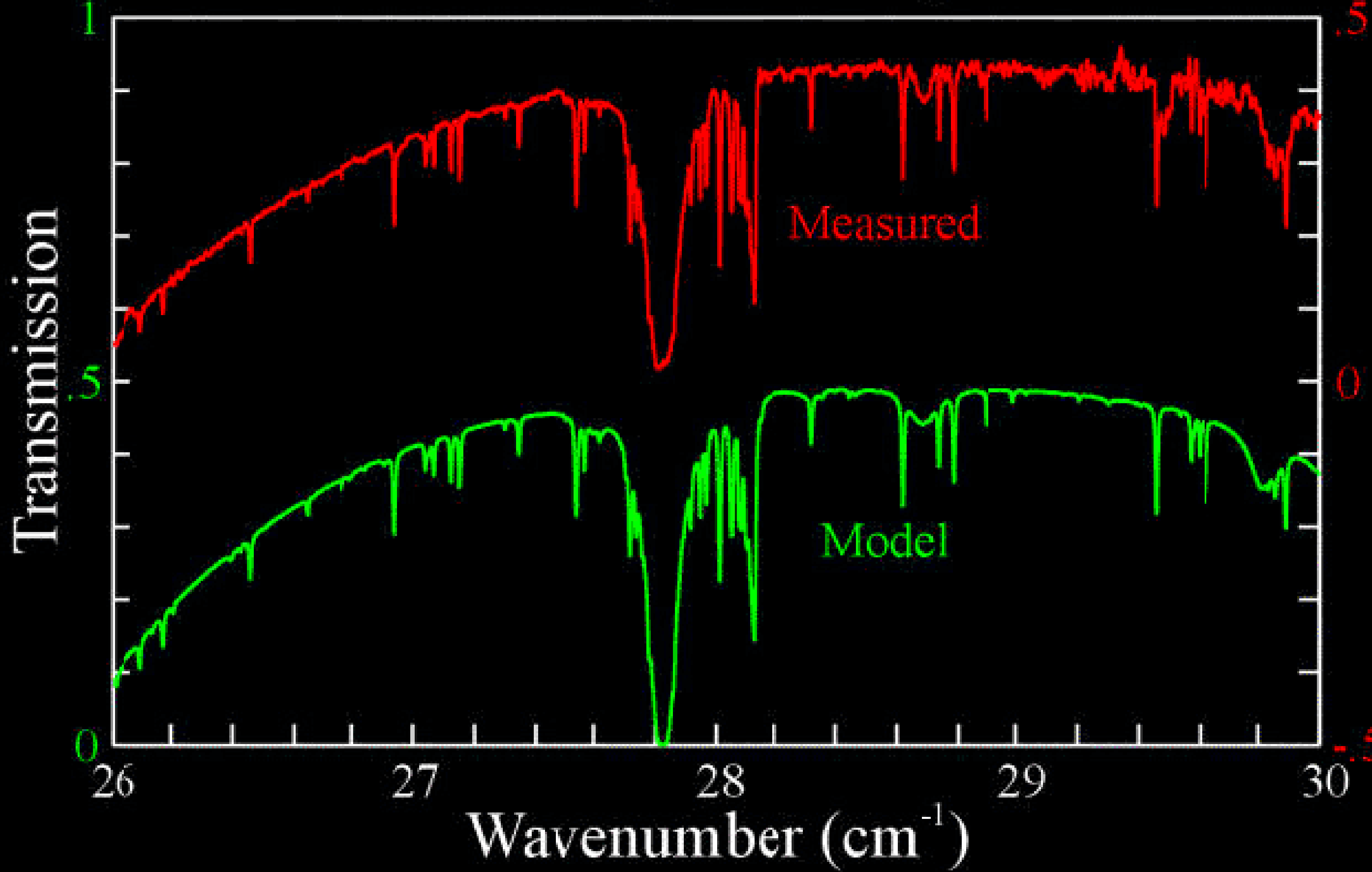




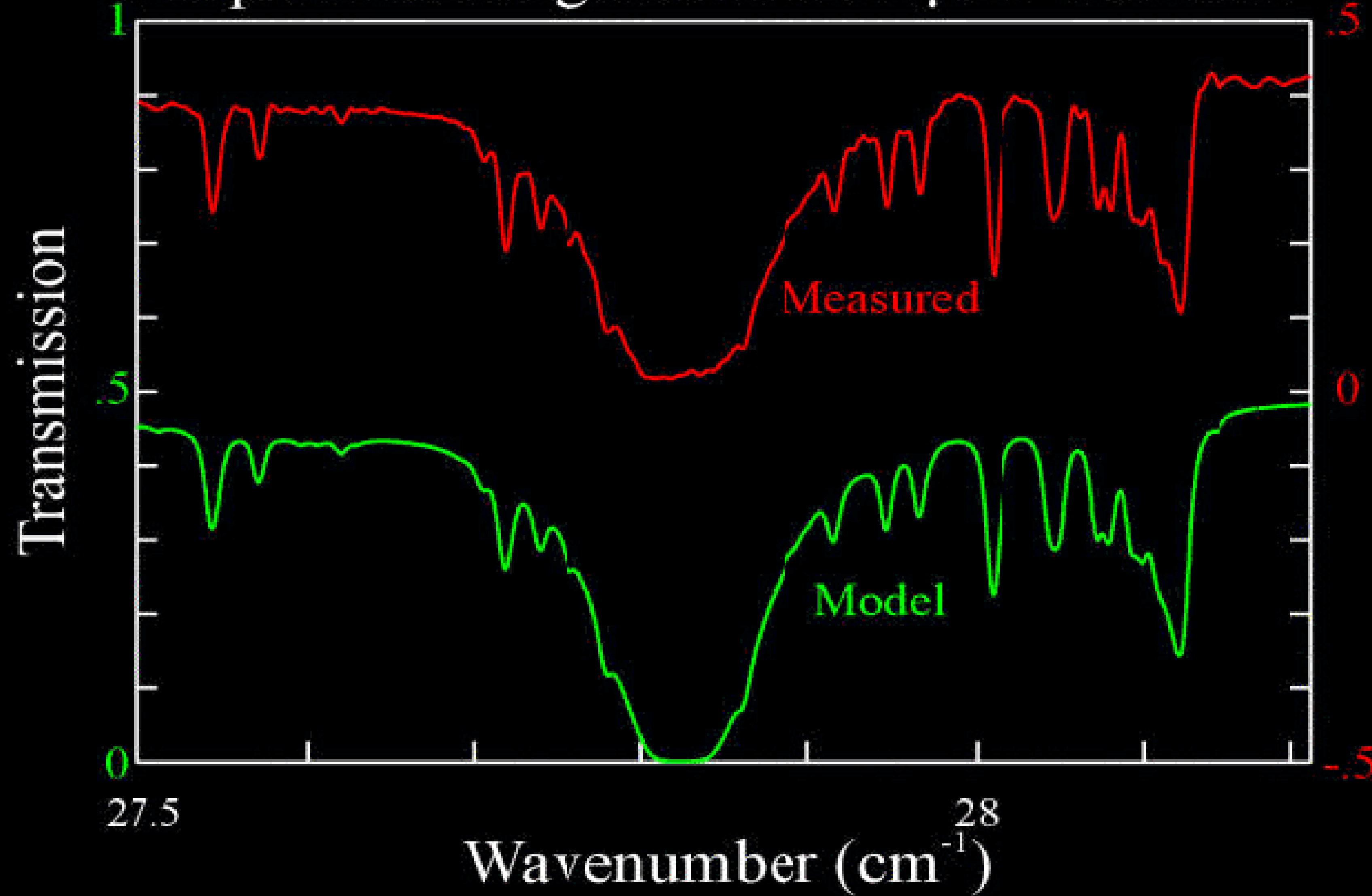

NTD Ge
Bolometer
Crystal
Silicon
Nitride
Spiderweb
Abscrber

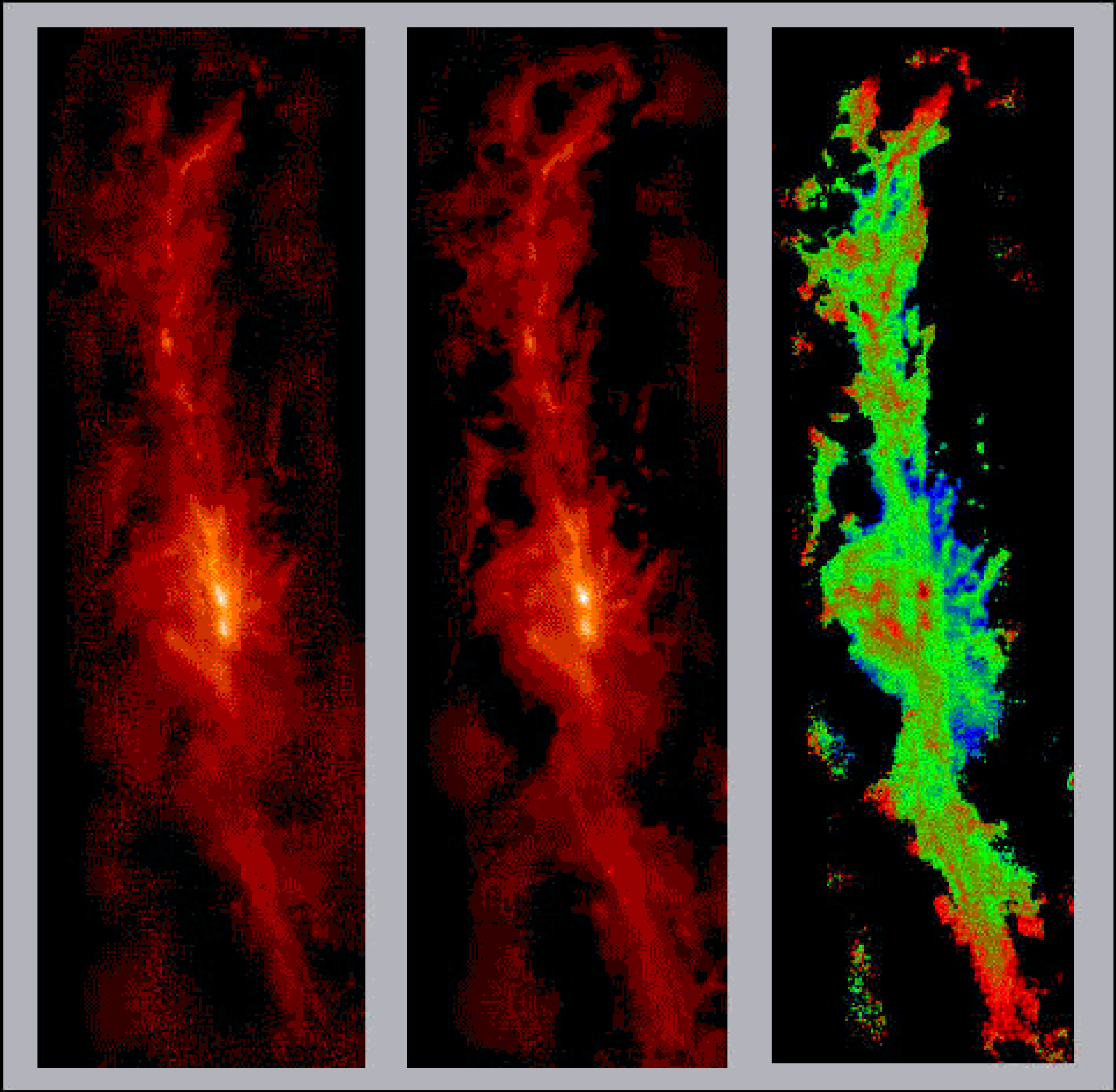

Frequency (GHz)
200
400
600
800
1000
Transmission
1.0
0.8
0.6
0.4
0.2
0.0
5
10
15
20
25
30
35
Wavenumber (cm^{-1})

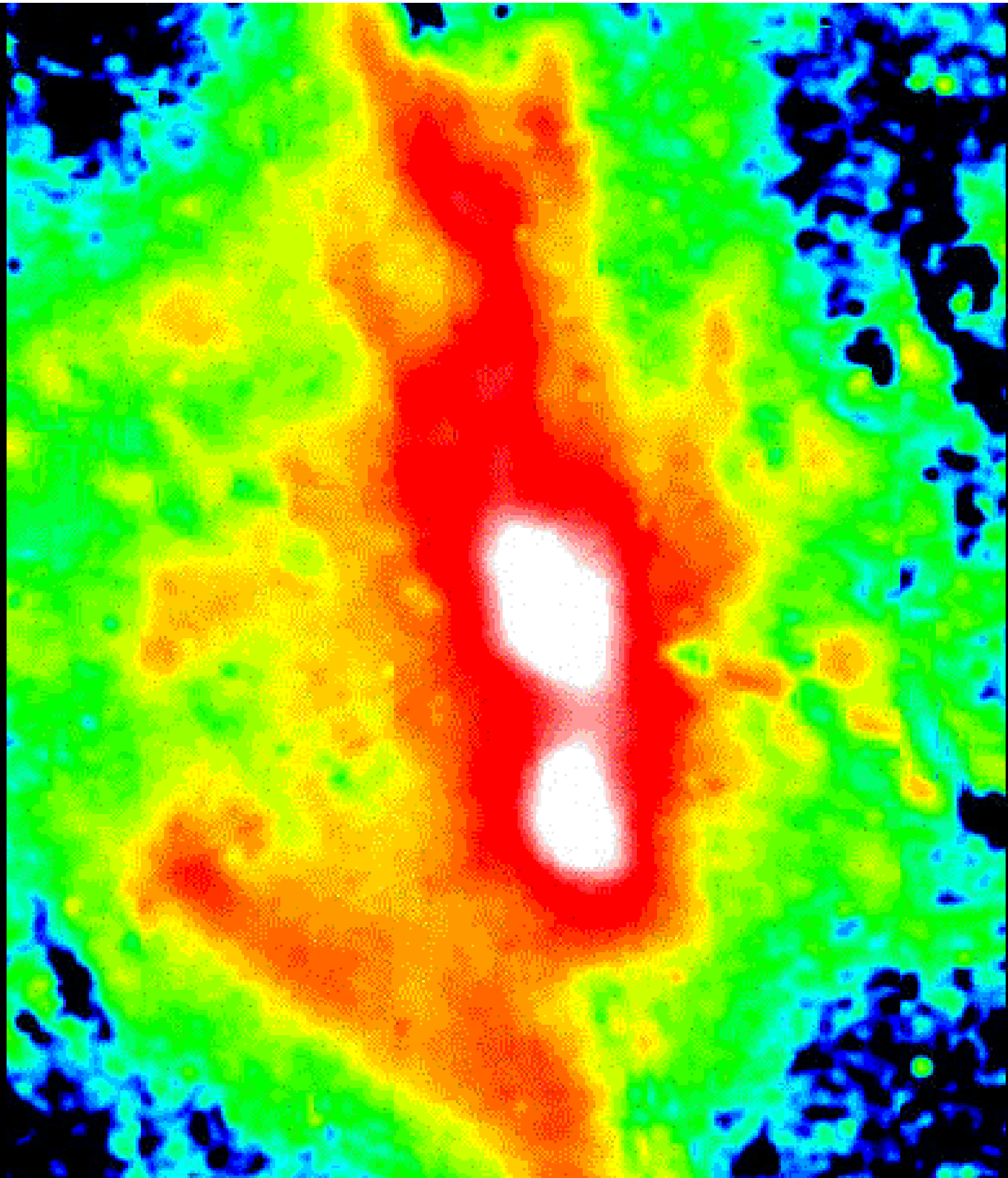
Transmission of 350 μm Atmospheric Window

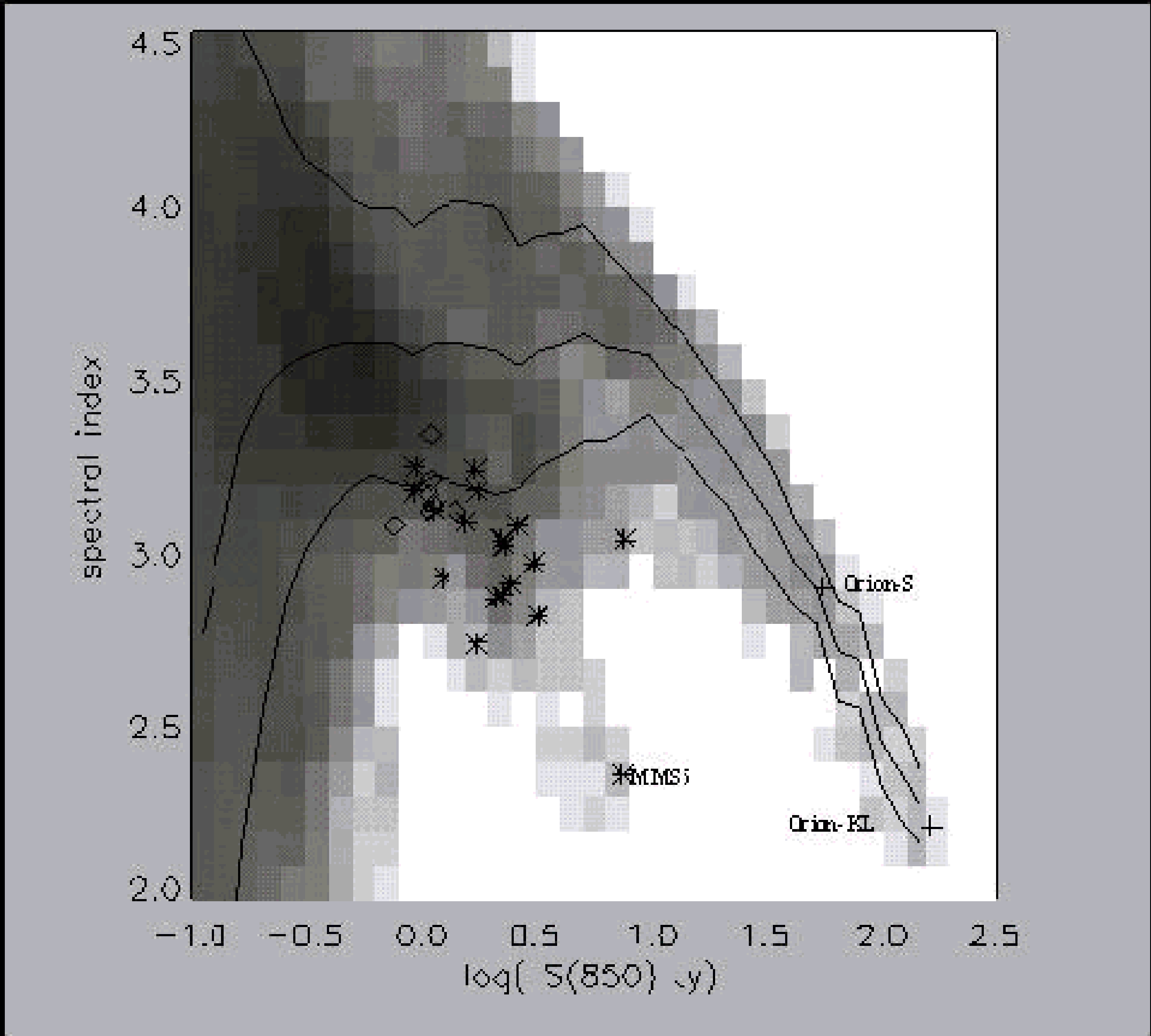


Expanded Region of 350 μm Window



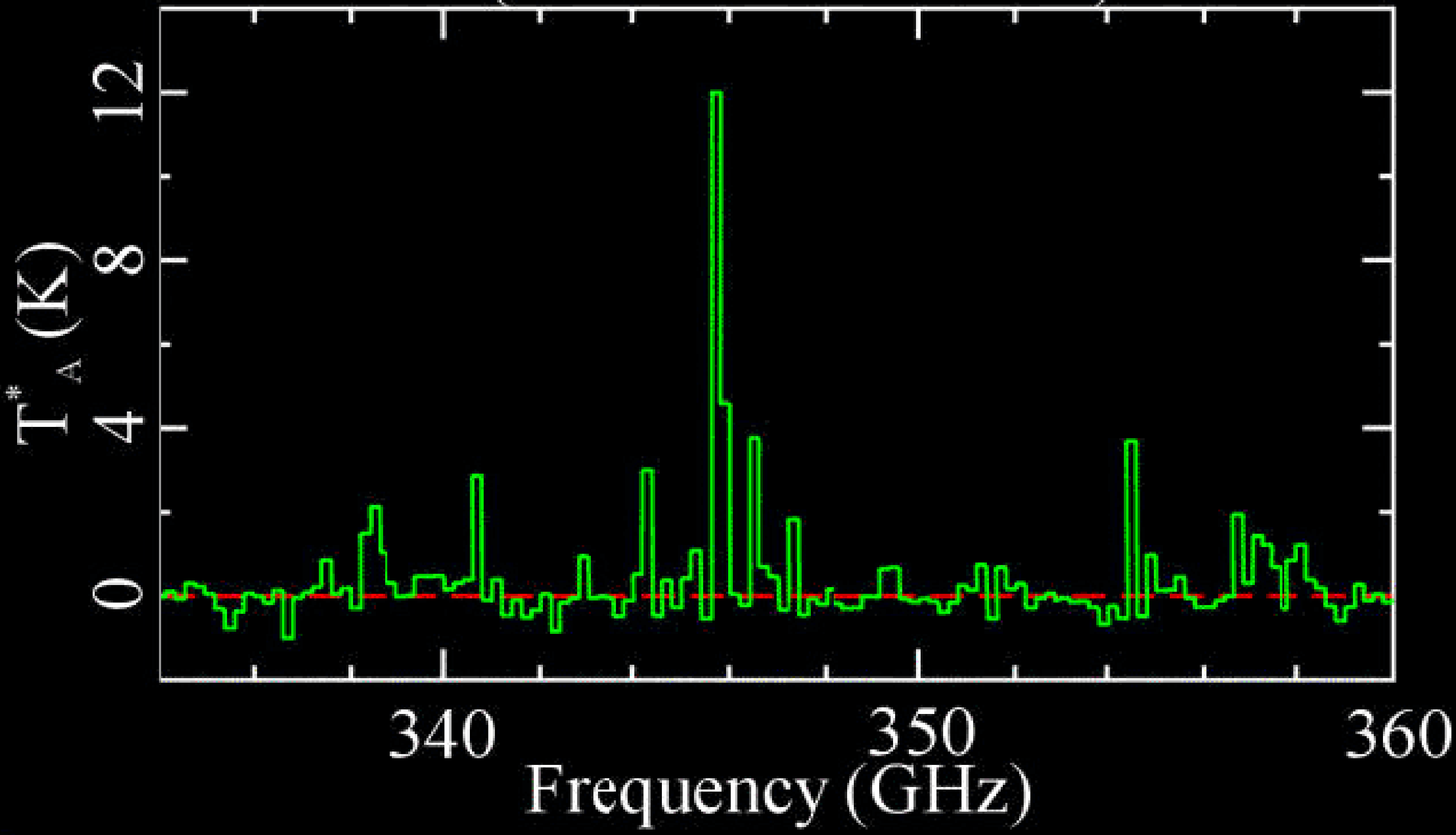


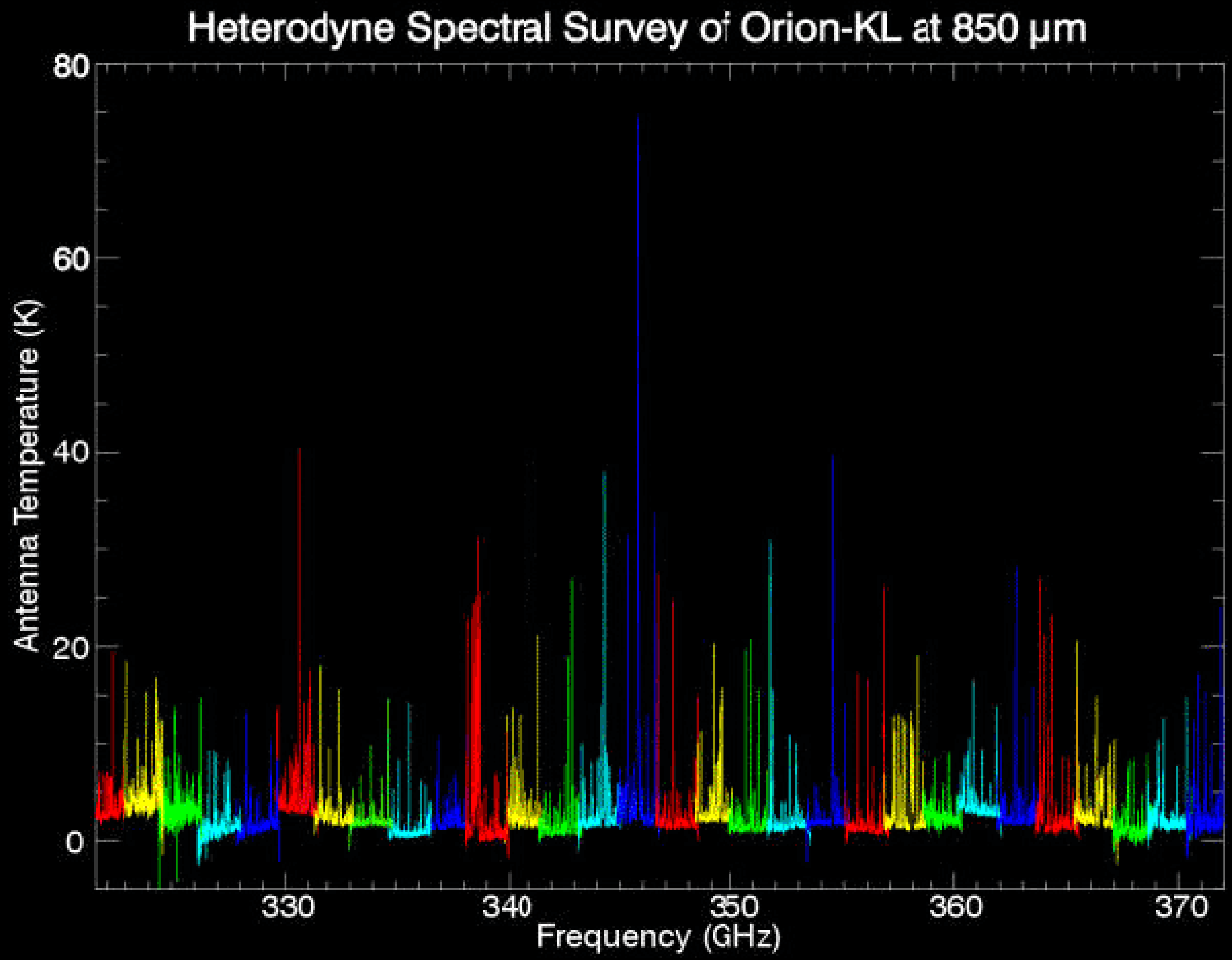




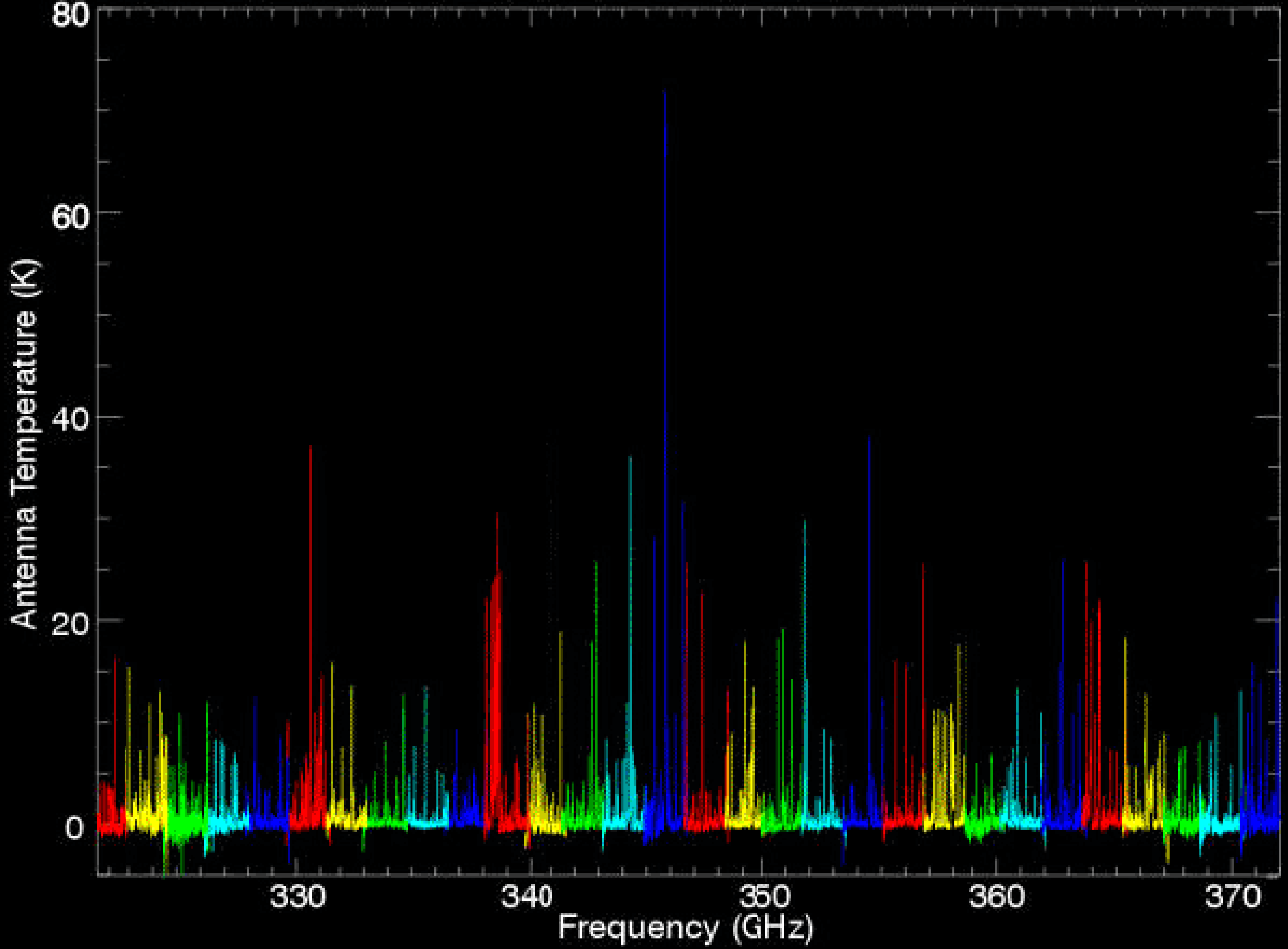
4.5
4.0
3.5
3.0
2.5
2.0
spectral index
-1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5
log(S(850) Jy)
Orion-S
MMS5
Orion-KL

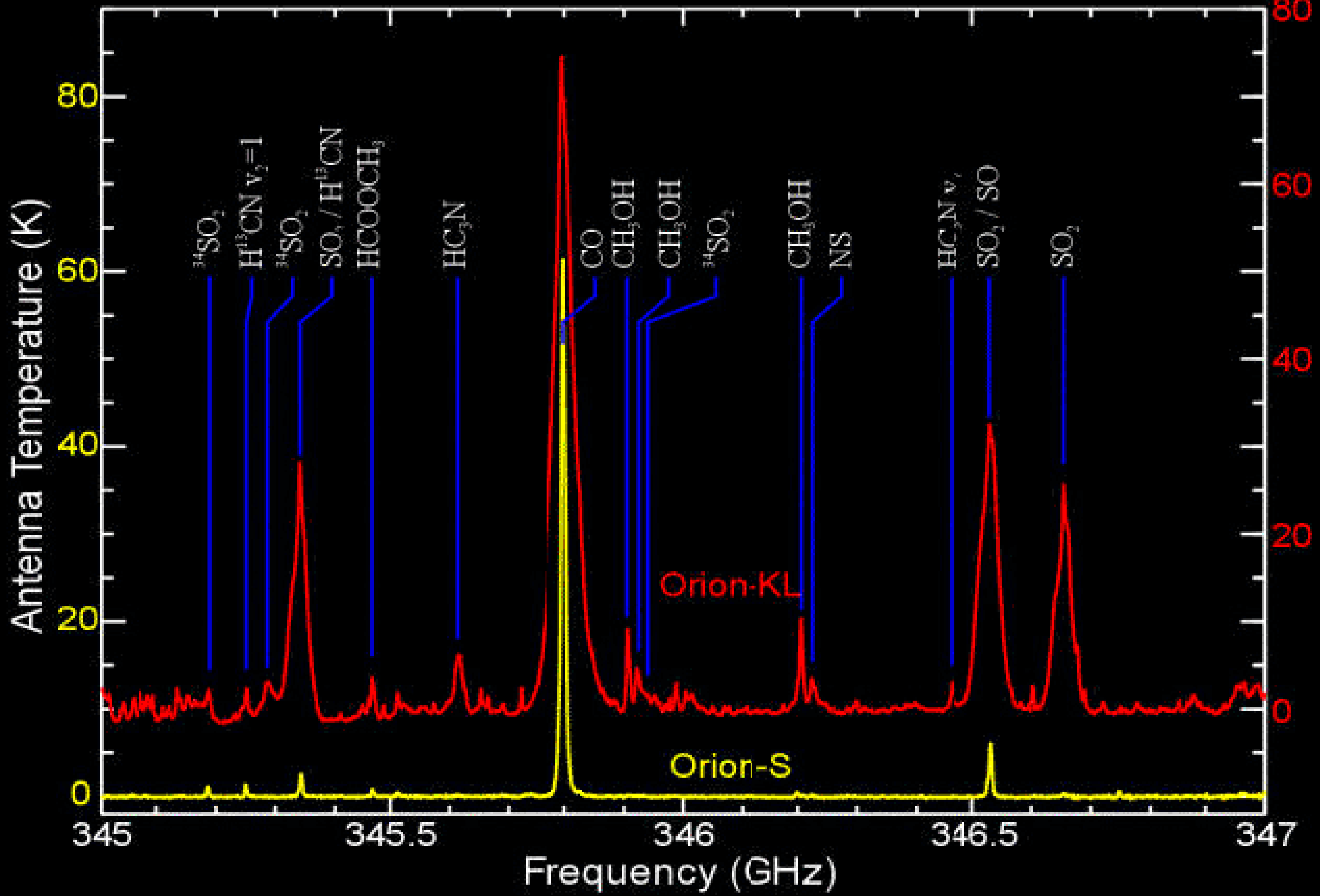
CSO FTS Scan of Orion-KL (baseline removed)

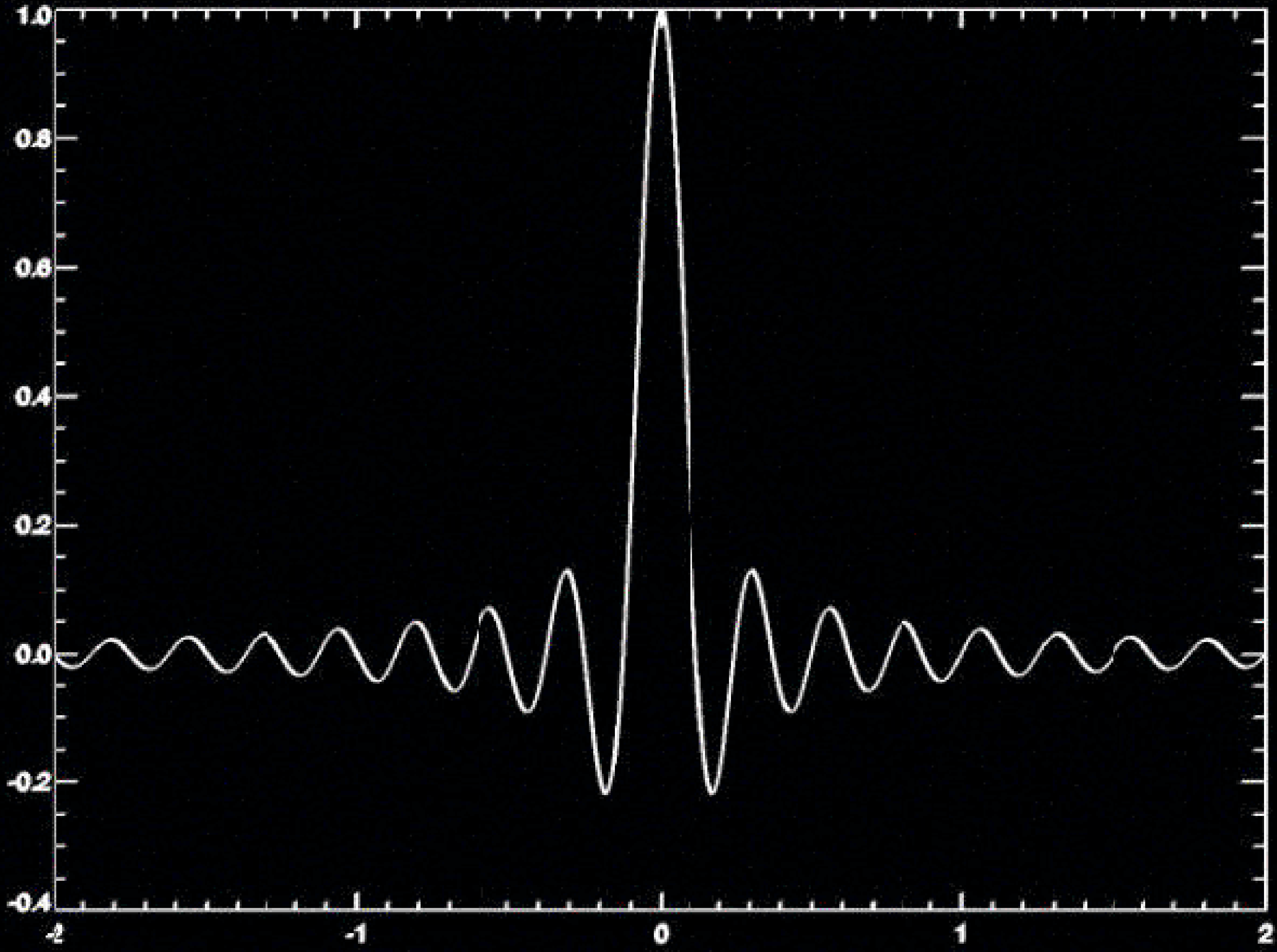



Heterodyne Spectral Survey of Orion-KL at 850 µm
80
60
40
20
0
Antenna Temperature (K)
330
340
350
360
370
Frequency (GHz)

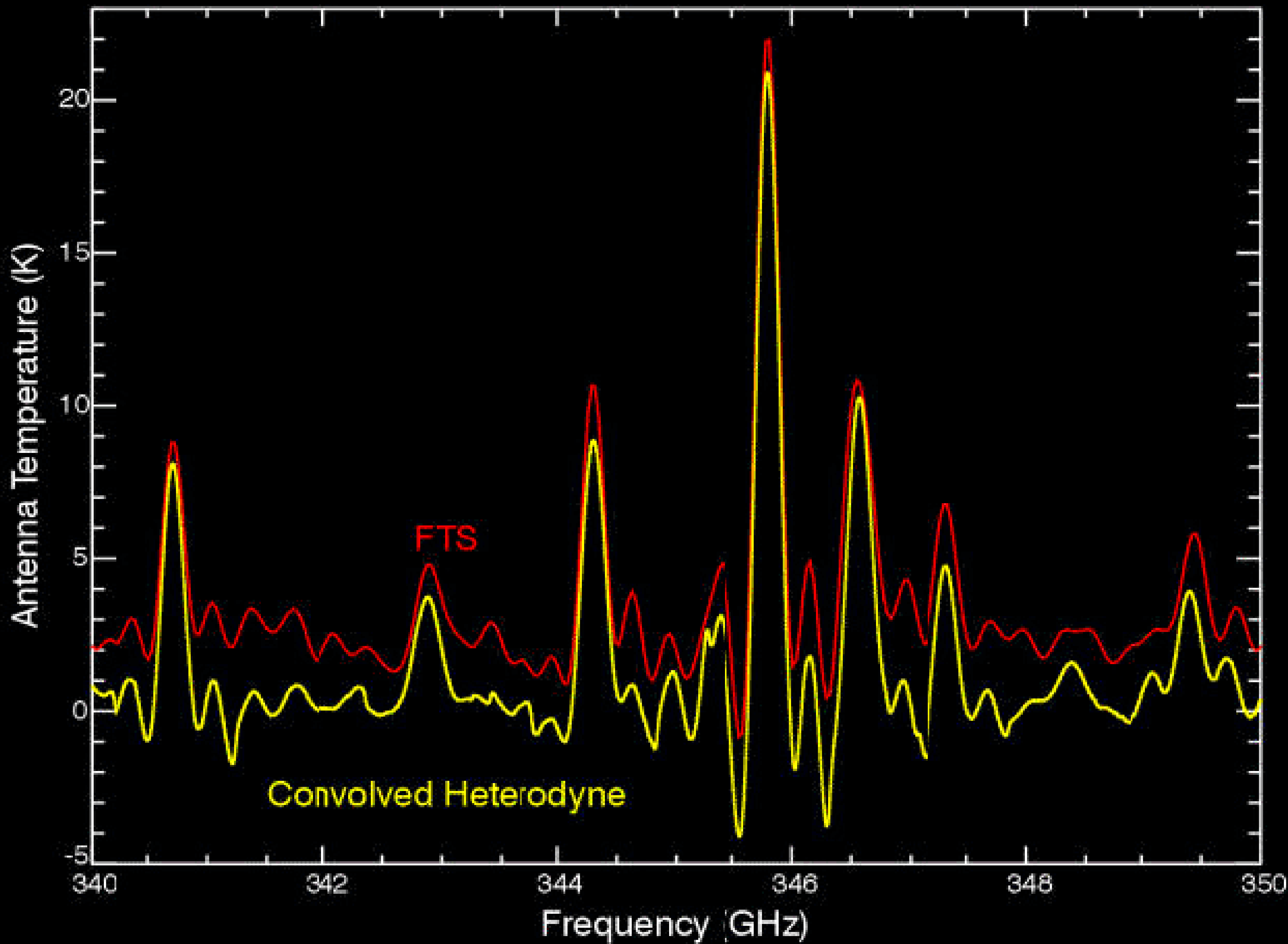
Heterodyne Spectral Survey of Orion-KL at 850 µm (baseline corrected)

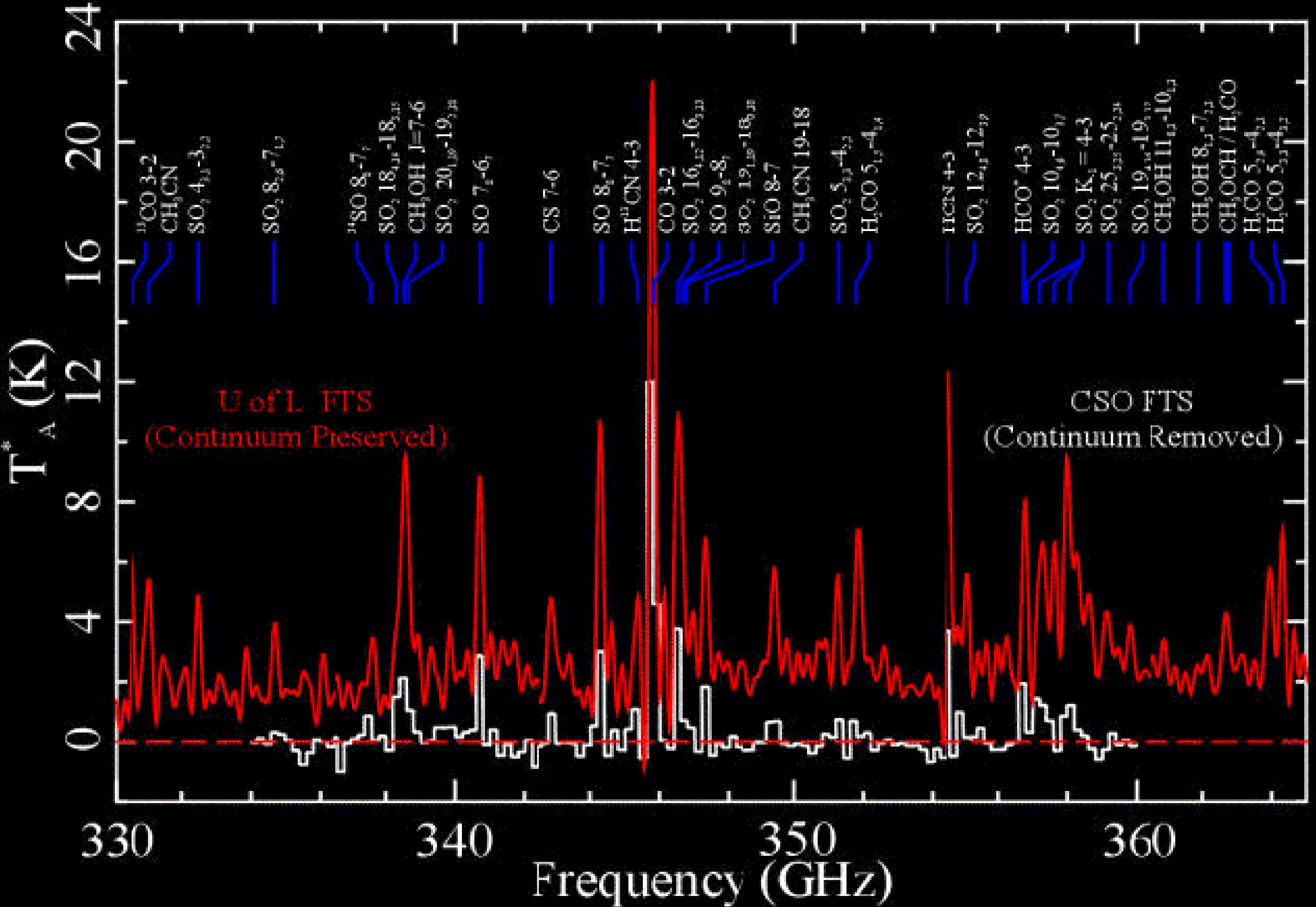



$^{34}SO_2$
$H^{13}CN$ $v_2=1$
$^{34}SO_2$
SO_2 / $H^{13}CN$
$HCOOCH_3$
HC_3N
CO
CH_3OH
CH_3OH
$^{34}SO_2$
CH_3OH
NS
HC_3N v_7
SO_2 / SO
SO_2
Orion-KL
Orion-S
Antenna Temperature (K)
Frequency (GHz)
345
345.5
346
346.5
347
0
20
40
60
80



1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-2
-1
0
1
2


Antenna Temperature (K)
Frequency (GHz)
FTS
Convolved Heterodyne
20
15
10
5
0
-5
340
342
344
346
348
350



T^*_A (K)
Frequency (GHz)
U of L FTS
(Continuum Preserved)
CSO FTS
(Continuum Removed)
CO 3-2
CS 7-6
HCN 4-3
SiO 8-7
CH3CN 19-18
HCO+ 4-3
0
4
8
12
16
20
24
330
340
350
360

Results

- First simultaneous broadband detection of line and continuum emission in SCUBA band

- Over 1000 lines in heterodyne scan of Orion KL; integrated flux
  FTS 34.1 vs Heterodyne 35.7 (K GHz)

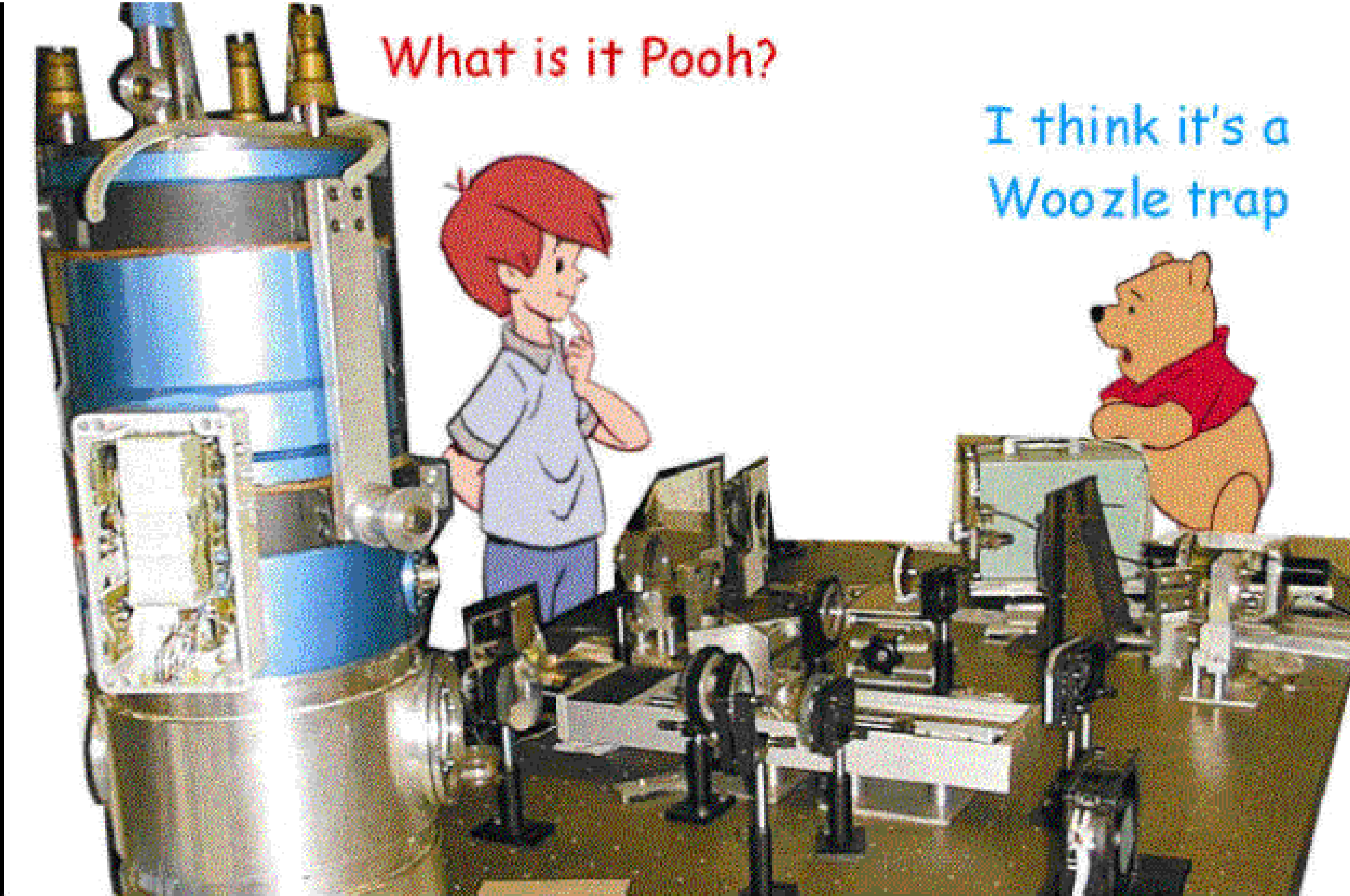
- Line contribution 32% for Orion KL (Serabyn 25%; Groesbeck 50%)

- Continuum temperature ~2.2K

- Good agreement between FTS and sinc * heterodyne spectra

Mach-Zehnder FTS Characteristics

Interferometer	Mach-Zehnder, double input, double output
Scan Mode	Rapid scan, maximum scan time: 20 - 60 seconds
Spectral Bands	350 µm, 450 µm, 750 µm, 850 µm, 1100 µm
Resolution	.005 cm^{-1}, 150 MHz, R ~ 6x10^3 or 50 km/s @ 30 cm^{-1}
Beamsplitter	Intensity beamdividers
Detector	Silicon nitride spiderweb bolometer, 0.3 K
Beam Width	7" – 19" (FWHM)
NET	< 50mK 850 µm per resolution element 1 hour integration
	< 250mK 350 - 450 µm per resolution element 1 hour integration



The FTS group welcomes collaborations!

Naylor@uleth.ca

Splinter Meeting Report: Galaxies in the local Universe

Laurent Vigroux and Gillian Wright

3 major programs

1) Unbiased sample of local galaxies

2) Spectro imagery of a sample of nearby resolved galaxies

3) study of the effect of environment on galaxy evolution

Unbiased sample of local galaxies

Goals

Study galaxy integrated sub-mm luminosity and correlations with the galaxy properties

Obtain a local luminosity function

Obtain a local reference sample to compare with distant galaxy samples derived from cosmological surveys

Problems and uncertainties

Can this sample be obtained as a by product from the cosmological survey ?

How many galaxies are needed ?

Framework

Fit well within Archive Survey concept

The sample should be complemented by Planck sources for the high luminosity

A subsample should be also observed with PACS, but mapping speed difficulty

Detailed studies of nearby resolved galaxies

Goals

Study the physics of sub-mm emission in galaxies

Obtain spatial distribution of dust and gas and study correlations with other components and properties

Study relationship between sub-mm emission and star formation

Sample

Need about 100 galaxies spanning Huble type and luminosity range including ULIRGS

Problems and uncertainties

Which galaxies should be observed ?
Design an observing strategy with photometer and FTS, and associated PACS observations
What can be done on AGN and radio galaxies ?

Framework

Fit well within Archive Survey concept with a possible exception for AGN and radio galaxies
Should be done together with PACS

Environmental effects on galaxy evolution

Goals

Study the physics of FIR and sub-mm emissions in galaxies in different environment

Sample

Coma cluster and South extension

A more distant rich cluster

Problems and uncertainties

Design the observing strategy with photometer and associated PACS observations

Faisibility of the observation of the distant cluster

Framework

Fit well within Archive Survey concept
Should be done together with PACS

Collaborations and future works

Collaborations with Planck/HFI, PACS and to a lesser extent with HIFI consortium are needed

How to organize these collaborations ?

Within Herschel :	**supervision by the HST**
With Planck :	**restart joint WG Planck/Herschell**

Local Galaxies surveys fit with the concept of Archive Survey

But

We do not wait a decision about this concept to define what should be done for these observations

Organization of future works

4 studies should be started soon to define in more details these observations, what is needed in term of complementary obervations, and scientific outcomes

Sue Madden	**Nearby and resolved galaxies**
Dave Clements	**Clusters**
Jason Stevens	**AGN and radio galaxies**
Steve Eal , Matt Page, and Walter Gears :	**unbiased sample**

Galactic Pointed Observations

Splinter Report

Paolo Saraceno
and
Peter Ade

Our Brief

- **Identify science proposals for the GT**
  - **50% shared with community**
  - **50% Our own**
- **Two pointed galactic survey types**
  - **Photometric**
  - **Spectral**
- **Prioritise Surveys**

What do we mean by a pointed observation?

It’s a source we have known coordinates for.

Observation modes could be Jiggle map or scan map.

Some discussion on mapping observations versus pointed observations

Which do we do first?

A map will provide data on many point like sources and may be the most efficient way to get the data we need.

Final programmes may be intertwined for maximum efficiency.

What Herschel science do we want to do?

Astrophysics drivers

Dust properties

Cooling mechanisms (efficiency) of Interstellar clouds

Chemistry of the ISM

Physical properties of ISM

Coupling of gas and dust (both interstellar and circumstellar).

Sources

Clusters

Outflows

Prestellar cores

The Galactic Centre (environment)

Photo-Dissociation Regions

Shock regions

Planetary nebulae interactions with ISM

Supernovae interactions with ISM

Pointed observation of fossil dust shells

Dust debris discs around main sequence stars

What are our priorities?

SPECTROSCOPIC

Effectiveness of cooling through line emission

Interaction of radiation with dust

Emissivity of dust (cooling)

Follow up of mapping surveys (determine gas/dust temp., density)

Dust in debris discs

PHOTOMETRIC

Dust characterisation

Source morphology (jiggle map)

Follow up of mapping surveys

Accurate SEDs of massive protostars

50% of the GT time is ours should we collaborate or establish an independent programme?

- We have to collaborate on core programmes
- We expect that there will be much overlap with the other instrument teams - the scientific aims are the same so instrument teams will be merged to attack specific science goals
- We need wide expertise to be effective in our analysis - add appropriate experts
- We therefore concluded that an open collaboration was best

The "Archive Building" scenario is actively being discussed - should we adopt it?

This is a new category of time - neither open nor GT.

It will be mainly for a core survey science.

Instrument teams involved in the ICC will need to be properly resource to do this work.

Should there be a coordinator?

We decided that this question is not applicable to the pointed galactic team.

Summary of Extragalactic Deep Surveys Splinter

Jamie Bock & Walter Gear

Top priority is 3-tier 'wedding-cake' approach to deep surveys

Medium Survey [~100 sq degrees to ~15 mJy (5sigma)]

- Source counts dN/dS
- Statistics of detected sources (clustering, LSS, etc)
- Redshift counts dN/dSdz
- Source phenomenology

P(D) Deep Survey [~1 square degree to ~5 mJy (5sigma)]

- Extends dN/dS below confusion limit

Shallow Survey [~400 square degrees to ~50 mJy (5sigma)]

- Large-scale statistics of background
- May be possible to combine with low-z survey
- Cross-calibration with Planck

Issues

- Medium and shallow surveys are clearly “key programmes” and by deftn collaborative => ideal for archive-building phase
- P(D) survey may be quite short and GT hence appropriate for GT only. Do it early to get instrument sytematic information ?
- We need coordination with other facilities, esp. Planck HFI and PACs => working group
- Need to carefully select fields to maximise information at other wavelengths
- Lots more work still to be done to optimise survey area/depth, different approaches still welcome as still have plenty of time. Get together regularly to discuss progress.

Other potential GT surveys

- **Planck ECSC follow-up**
  - Highly luminous galaxies photometry & spectroscopy
  - Lensed systems
- **Cluster lensing surveys**
  - Extend dN/dS to lower luminosity limit and higher redshift. Small fields so could do ~10 easily in GT
- **Known high -z sources**
  - observe existing samples for comparison with survey objects
- **FTS blind surveys**
  - find samples of line-selected objects automatically get z.
  - Needs simulations to determine feasibility though
- **Cluster S-Z survey**
  - Assess electron temperature through relativistic S-Z
  - Point source contamination
  - Intra-cluster dust

Splinter Meeting Report: Galactic Surveys

Phlippe André and Bruce Swinyard

What surveys do we want to do?

0.Full 360 longitude galactic plane 70 days
1.Gould belt/nearby cloud complexes (dual SPIRE/PACS)   30 days
2.Cirrus survey to complement Planck 15 days
3.Medium resolution spectral survey of the galactic centre 200 days full spatial resolution a few days for sparse spatial sampling
4.Spectral/spatial maps of isolated pre-stellar cores (niche area for FTS) (a few hundred) 30 days

Do we want these as GT or to propose them as "key projects"?
Key project has to take ~50 days of 100 days actual GT. Rest is "free" to use as we wish.

0.This would come out of GT anyway
1. Co-ordinated with PACS consortium. Do this with a mixture of GT and OT. High priority for survey.
2. Low priority – planck pays for this
3. Sparse is viable – high spatial resolution non-starter - Sparse map is definite for GT – A few days
4. High priority to do as many as possible with GT programme. Prioty list to be established and top portion fitted to available time.

What do we think about "Archive Building"?
Galactic plane survey should be of this class and treated as Herschel time. Seen as a very high priority for galactic observations with Herschel. in order to process the data for public access we will need support for this from ESA/national agencies.

The nearby clouds will contain a lot of "favourite" objects – should this also be a Herschel time observation?

Solar System Programme

Splinter Report

Gary Davis and Therese Encrenaz

Potential Scientific Programmes:

1. H_2O in the Solar System
2. Far-IR photometry of TNOs
3. Formation and evolution of the Giant Planets
4. Mars aeronomy and photochemistry
5. Chemical composition of small bodies

1. H_2O in the Solar System (1)

1. Comets

- H_2O is main constituent
  - ***Many rotational lines within HSO spectral range***
- Scientific goals: production rate, kinematics, physical conditions, spin temperature, D/H
  - ***All 3 instruments***
- SPIRE: water production rate, isotopic composition, ortho:para ratio
  - ***Need to measure several lines simultaneously***
  - ***FTS is ideal***
- Characterise variability
- Visibility limitations

H_2O in the Solar System (2)

2. Giant Planets

- **Science:**
  - ***Discovered by ISO/LWS and ISO/SWS in stratospheres of all giant planets and Titan***
  - ***External origin but source unclear***
  - ***Goal: measure vertical distribution***
- **Brightness constraint:**
  - ***Jupiter and Saturn too bright to observe***
  - ***Uranus bright, will require specific calibration***
  - ***Neptune OK***
- **Spectral resolution:**
  - ***Stratospheric emission lines are narrow***
  - ***SPIRE-FTS resolution insufficient; HIFI***

3. Mars

- **Science: D/H, water cycle**
- **Too bright to observe with SPIRE**

2. Far-IR Photometry of TNOs

Science:

- **Statistical study to characterise temperature, radius, albedo**
- **PACS, SPIRE**

Constraints:

- **Faint: can’t easily go below 10 mJy with SPIRE due to confusion**
  - ***e.g., Varuna: 3 mJy at 850μm***
  - ***PACS may be better-suited***
- **Ground-based observations may be feasible as follow-up to PACS**
  - ***SCUBA, ALMA***

Conclude:

- **More work to be done to establish feasibility of this programme**

3. Formation and Evolution of the Giant Planets

D/H:

- **High priority: tracer of primordial D/H and planetary formation process**
- **Measured with ISO/LWS and ISO/SWS**
- **R(0) line of HD at 112μm: PACS**

He/H:

- **Tracer of primordial He/H and planetary interior structure**
- **Determine from continuum**
- **Jupiter and Saturn: too bright for SPIRE; value already known**
- **Uranus and Neptune: follow-up on ISO/LWS**
  - ***Neptune as potential calibration target***

P/H in Uranus and Neptune:

- **Detect PH_3 from ground using Lethbridge FTS on JCMT**

4. Mars Aeronomy and Photochemistry

- Too bright for SPIRE
- Might be possible with PACS
- Lines are narrow: appropriate for HIFI
- Spatially unresolved

5. Chemical Composition of Small Bodies

- **Asteroids, Galilean satellites**
- **Overlap with calibration programme**
- **Requires photometry and spectroscopy**
- **Unclear whether there is anything to be gained at these wavelengths**
  - ***Mineralogical features in submm?***

Conclusions

Scientific Priorities:

- **H_2O in comets and giant planets (SPIRE-FTS, HIFI)**
- **D/H and He/H in giant planets (PACS, SPIRE-FTS)**

Collaboration with other HSO consortia:

- **Obvious and natural for Solar System**

Archive-building scenario:

- **Cometary programme lends itself to large-scale observing strategy**

SPIRE

Steering Group Meeting Summary

- **New associates appointed - now have about 80**
- **Funding summary - very tight all round**
- **De-scope possibilities**
  - **Technical: FTS**
  - **Budget:**
    - **Don't build flight spare**
    - **Descope BSM**
    - **De-scope ICC effort**
- **ICC important and must be properly resourced, but hardware descope is unrecoverable so should be avoided**

SPIRE

Meeting Summary

Matt Griffin

SPIRE

Co-Is' Meeting Summary

- **FTS bands: Some study needed to optimise horns but not much time**

- **Photometer bands**
  - **No change unless strong scientific case is made**
  - **Many technical and schedule constraints**

- **Associate Scientist list reviewed**

- **Scientific constitution**
  - **Principles agreed at Saclay meeting June 2000**
  - **Draft is being considered by Co-Is**

- **Topic Teams/SAGS: No ideal set, but what is proposed is about right**

- **Project management and organisation**
  - **Improvement will be made through**
    - **Enhancement of central RAL team**
    - **Proper attention to the project at institute level**

SPIRE

Associate Scientists

- List of 60 was given in the SPIRE proposal
- List of 23 additional Associates was approved by SPIRE Steering Group
- Strong team with no major gaps in expertise
- List will grow as new people join the project
- Associate Scientists are associated with a particular Co-I
- Reward will be proportional to effort
- Co-Is will monitor their Associates’s activity and make sure that their efforts are properly recognised

SPIRE

Herschel Observing Time

- Current rules are as given in the Science Management Plan
- "Archive Building" concept is viewed by SPIRE Consortium as worth developing further.

  Resource implications must be properly dealt with
- In any scenario, many programmes will require close collaboration with the PACS team
- SPIRE will develop plans for GT use and coordination based on the currently agreed SMP scheme, while participating in discussing/developing the Archive Building approach

SPIRE

Possible SAGs

- High-redshift surveys and follow-up
- Galaxies in the local universe
- Star formation
- Galactic ISM
- Solar system
- Stellar and circumstellar

Future work

Instrument

- Finalise the design and build it
- Next major review is the IBDR at the end of this year
- ICC: Finalise SIP and share out workpackages in the consortium

Scientific Programme

- Co-Is to agree Scientific Constitution
- Set up SAGs (membership and coordinators)
- Start discussion with PACS consortium on many collaborations
- Set up coordinated simulation group
- Hold meetings like this more often
- Monitor and participate in discussion of the “Archive Building” concept